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ELIHU THOMSON[1]

1853–1937

By Dr. KARL T. COMPTON

PRESIDENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FOR one destined to apply his genius largely toward harnessing electricity for the work and comfort of man, the decade beginning with 1850 was a timely period in which to be born. The preceding half century had witnessed the fundamental discoveries which underlie the utilization of electricity, and imaginative minds had begun to direct these discoveries into the broad channels of practical and commercial employment.

In the development of the electrical art this first half of the nineteenth century was a remarkable fifty years, and because it provided the foundation for the practical achievements which came in the second half, a review of it helps to give perspective to this memoir on Elihu Thomson.

The century opened auspiciously with Volta's discovery of the voltaic cell, and with the demonstration by Nicholson and Carlisle of electrolysis. In 1820 Oersted announced his discovery that an electric current has the power to deflect a magnetic needle. In this same year Ampere brilliantly elucidated Oersted's discovery by giving mathematical expression to the forces produced by electric currents. Six years later Ohm announced the formulation of his law that current is proportional to the electromotive force, and

[1] Condensed from a memoir presented to the National Academy of Sciences.

twenty years later Gauss and Weber invented an acceptable system of electrical and magnetic units.

Meanwhile, Faraday had begun the epochal researches which were to lay the foundations of electrical engineering. In 1821 he had succeeded in making a wire revolve about a magnet and a magnet about a wire, and ten years later, almost simultaneously with Henry in America, he made the great discovery underlying almost all electrical machinery—electromagnetic induction. This led him to the mechanical production of a steady electric current by revolving a copper disc between the poles of a magnet.

Minds with a practical bent were quick to follow the road which Faraday and Henry had pointed out. By 1850, the electric motor had been demonstrated, the commutator had been devised, the electric arc had been experimentally used for lighting, and efforts had been made to drive boats, buggies and locomotives by electricity. But the conquest of electric power was still thwarted by practical difficulties; only in the form of the telegraph and a few other devices had electricity been put to work effectively.

It was during this stage in the development of the electrical arc that Elihu Thomson was born in 1853, and it was not until he had embarked upon his professional career at the tender age of 17 and was ready to join the creative thrust that the drive toward economic utilization of electric power had really begun to gain ground rapidly. In 1875, five years after Gramme had built his ring-wound armature, and along with Siemens had made the dynamo a practical machine, Thomson had built a dynamo and by 1879 he had invented and patented a three-coil arc dynamo —a pioneer three-phase generator. He thus early took prominent place in the brilliant group, including Brush, Edison, Siemens, Stanley, Tesla, Van Depoele, Weston and others, which was to solve the problem of generating adequate current. The electrical tide was approaching its flood and Thomson was ready—with consequences important to the development of the electrical industry.

The young man who thus auspiciously began his career in Philadelphia was born in Manchester, England, on March 29, 1853, of a Scotch father, Daniel, and an English mother, Mary Rhodes. Elihu was the second son of the family, which ultimately was to total eleven children, six boys and five girls. Four years after Elihu's birth, the panic of 1857 struck England and his parents, moved by the resulting scarcity of work, decided to emigrate to America, which they did in 1858, settling in Philadelphia.

In February, 1866, Elihu was admitted to the Central High School in that city, even though he lacked several weeks of having attained the required age. Four years later he was graduated as fourth honor man and accepted employment in a commercial laboratory where analyses were made of iron ore and other minerals. He remained in this post for about six months and then returned to Central High School in the fall as "Adjunct to the Department of Chemistry" at a salary of $500 per year.[2]

One of the senior professors whom he assisted in this post was Edwin J. Houston, who held the chair of physical geography and natural philosophy, and the two were soon engaged in collaborative investigations which led to a long partnership. The first publication growing out of their research was a paper "On a New Connection for the Induction Coil," contributed by Professor Houston to the June, 1871, issue of the *Journal of the Franklin Institute*. The paper contained an account of Thomson's observations of sparks drawn from grounded waterpipes during the operation of a nearby induction coil. Although he did not recognize the significance of the evidence at the time, he had clearly observed the propagation of electrical waves through space. When, in 1875, Edison announced a new "etheric" force which he described as non-electrical, Professor Thomson was primed to dispute his conclusions, for he wrote later:

> I had proposed to Houston that we carry on these experiments and show definitely that the so-called "etheric" force that Edison had announced in the papers was merely an electrical phenomenon. At this time I took upon myself the enlargement of the scale of the experiments, so as actually to obtain a very definite result. This was carried out, as follows, in 1875. A 6-inch spark Ruhmkorff coil was set up with one terminal connected by a wire about 5 feet long to a large tin vessel mounted on a glass jar on the lecture table. When the coil was in operation, sparks were allowed to jump across the terminals of the coil itself, these sparks being about 1½ inches to 2 inches long and having the character of condenser sparks. When the coil was in action, I explored the whole building throughout the several floors and then went up to the top of the building to the observatory, where Professor Snyder had charge of the astronomical instruments. It was found that tiny sparks could be obtained from metal objects wherever they were, in the cases or outside, from the door-knobs or from apparatus, by the simple expedient of shading from the light and detecting the tiny sparks with a pointed pencil by applying it, say, to the door-knob. I recognized clearly that this was a manifestation of electric waves passed through space, and I also understood that a system of communication might readily be based thereon.[3]

A description of this experiment was communicated to the Franklin Institute by Professor Houston and printed in its *Journal* for January, 1876. With the

[2] "The Philadelphia Period in the Life of Professor Elihu Thomson," by John Louis Haney. *The Barnwell Bulletin* of Central High School, February, 1939.

[3] Unpublished notes of Professor Thomson in the files of J. A. McManus, General Electric Company, Lynn, Mass.

exception of Joseph Henry's experiments, which were unpublished, here was one of the first experimental demonstrations of the validity of Maxwell's theory, and here, too, was an example of Professor Thomson's extraordinary intuition anticipating the wireless transmission of signals over a decade before Hertz demonstrated electromagnetic waves and twenty odd years before Marconi received his patent on "telegraphy without wires."

Again in Thomson's nineteenth year, the *Journal of the Franklin Institute,* August, 1871, carried an account, written jointly by Thomson and Houston of further original work. This paper, "On the Change of Color Produced in Certain Chemical Compounds by Heat," was a pioneer discussion of this phenomenon. His next important paper, "On the Inhalation of Nitrous Oxide, Hydrogen, and other Gases and Gaseous Mixtures" appeared in the *Philadelphia Medical Times,* November 15, 1873, and foreshadowed his later work on the use of helium in diving and caisson work.

By 1877 Thomson was swinging into his full stride. He had received the master of arts degree from his institution and had been appointed professor of chemistry and mechanics. His capacity to work productively in a variety of fields had been amply demonstrated by creative work in both chemistry and physics. He had, during a series of successful lectures at the Franklin Institute, anticipated the system of electric-welding he was later to patent, he had conceived the idea of a cream separator, and he had described the operation of tuning one electrical circuit to another.

Thomson regarded his "more serious interest in electrical applications"[4] as beginning in 1878 with a series of tests on dynamos then in commercial use. This report had been preceded in the *Journal of the Franklin Institute* by papers on the relaying of the telephone and on "A New System of Electric Lighting and a New Form of Electric Lamp," and it was followed in 1879 by "Circumstances Influencing the Efficiency of Dynamo Electric Machines" published jointly with Professor Houston in the *Proceedings* of the American Philosophical Society. This paper, as did the report to the Franklin Institute, emphasized the advantage of low internal resistance in a dynamo as compared to the resistance of the external circuit.

It was in 1879 that he and Houston built a dynamo with three-phase winding. This machine, patented in 1880 and now at the Smithsonian Institution, was known as the "bakery machine" because of its use for lighting a large bakery in Philadelphia. "This is the machine," Thomson once noted, "upon which the Thomson-Houston Electric Company was based. . . . I think this is a very important invention, inasmuch as the great power generators of to-day are three-phase dynamo machines with three-phase armature winding. . . ."[5]

Having made fundamental improvements in the dynamo, Thomson and Houston, prompted by the commercial application of arc lighting by Brush, rapidly rounded out a complete and reliable arc-lighting system. They devised a constant current regulator (1881), an air blast method to extinguish or prevent the arc tending to occur when an electric circuit is opened (1882), and the magnetic blow-out (1883), which employs a magnetic field to extinguish an arc.

Of this arc-lighting development Dr. Dugald C. Jackson, the well-known electrical engineer, has said:

> Arc lighting has largely been superseded by later forms of electrical illumination, but I am personally inclined to put forward this invention of the automatically regulated dynamo for arc-lighting service as one of Thomson's most important, on account of its influence on his own work and the development of his opportunities. The invention was made when he was still in his twenties. It was carried through substantially on his own responsibility except for meager financial aid, and drew out at this early age, at least in some degree, those qualities of originality, courage, resourcefulness, far-sighted thinking and powers of experiment which were so notably the foundation for his distinguished and productive career.[6]

For similar reasons I have dwelt in detail on Professor Thomson's Philadelphia days, particularly on his work at Central High School. By the time he resigned from the school in 1880, he had unmistakably demonstrated his wide-ranging genius, and in his work there are to be found the seeds of his later achievements. Here it was, too, that he developed his lifelong interest in education and that fondness for teaching which led him throughout his life to cherish the title "Professor" above all others.

Professor Thomson resigned from Central High School to become "electrician" for the American Electric Company, a firm organized early in 1880 at New Britain, Conn., to control the Thomson-Houston patents. Two years later Thomson, at the suggestion of Charles A. Coffin of Lynn, Mass., formed the Thomson-Houston Company to take over the assets of the New Britain Company, and in 1883 the business was moved to Lynn. With Coffin assuming the burden of finance and management, Thomson was free to give undivided attention to research and technical development, and for the first time he was able to surround himself with competent assistants. The result of this happy arrangement was one of the most extraordinary

[4] "Pioneer Investigations on Dynamo Machines Fifty Years Ago," by Elihu Thomson. The *Journal of the Franklin Institute,* July, 1928.

[5] Unpublished notes of Professor Thomson in the files of J. A. McManus, General Electric Company, Lynn, Mass.

[6] Address of Dugald C. Jackson at the meeting in commemoration of the life and work of Elihu Thomson, February 16, 1939. In the files of the American Philosophical Society, Philadelphia.

records of technical achievement in the history of the electrical industry.

Founded in the period when Edison was demonstrating the commercial possibilities of electricity with his "Jumbo" dynamos, the company grew rapidly. In 1884 it employed 184 workers, but by 1892, when it was merged with its competitor, the Edison General Electric Company of Schenectady, the number had grown to 4,000.[7] The result of the merger was the General Electric Company, with Coffin as president and Rice, who had been manager of the Lynn plant, as vice-president and technical director. Not the least of Professor Thomson's contributions to the success of this great industrial organization was his demonstration of the value of industrial research.

Returning to the record of Professor Thomson's inventions, we find him in 1885 applying his magnetic blowout to lightning arresters. This fundamental method of breaking electric currents became the foundation for automatic circuit breakers and for controllers of electric cars and trains.

The basic idea of his lightning arrester derived from a knowledge and study of scientific phenomena involved in the discharge of electricity through gases. A transmission line, of course, has to be insulated from the earth by insulators adequate to prevent spark-over at the voltages used. If, however, the line is struck by lightning or an abnormally large electric surge passes through it, a spark may pass around the insulation, and it is a peculiarity of sparks through air that when once the insulation of the air is broken down by a spark there is no inherent limit to the amount of current which can flow. Thus these sparks frequently cause serious short circuits.

Professor Thomson's discovery consisted in placing the insulator between the poles of a magnet, with the result that the spark or arc which might be produced was acted on by electrical forces in such a way as to elongate it in the form of a bow which became more and more extended until it finally became so long that it went out.

Again in these early days and long before the importance of it was understood, Thomson had outlined the now universally used method of transmitting alternating current by transformers. He had written out a description of the system in 1878 and set up a working model at the Franklin Institute in 1879, but his patent application was not filed until 1885. After an unusually strenuous history in the Patent Office because of interferences with the work of Gaulard, Gibbs, Brush and others, the patent did not issue until 1902. When it did issue it covered every alternating current distribution system in the country, and it is not surprising, therefore, that the courts subsequently held the patent invalid.

In the further development of alternating current machinery he devised constant current transformers embodying the magnetic leakage shunt (1889), and a movable secondary (1894), which could be adjusted in relation to a fixed primary, to give constant current output. Again, in the direction of increasing the power capacity of transformers, he obtained patents in 1890 covering the cooling of transformers by oil immersion and by air.

One of Professor Thomson's most fundamental discoveries was the principle of dynamical repulsion between a primary and secondary coil. This can be demonstrated by a variety of interesting lecture experiments, most of which were suggested and shown first by Professor Thomson himself. One of these experiments still serves as a spectacular demonstration for popular science lectures and for elementary classes in physics. A vertical wire coil is surrounded by a spool of wire through which a large current can be passed upon throwing a switch. A metal ring which slips easily over this core is dropped around it from above. Immediately upon closing the circuit this ring is shot up into the air by the repulsive action of the electric current produced in the ring and the primary current in the coil. This scientific observation was developed by Professor Thomson into an alternating current repulsion motor which is nothing more nor less than our present repulsion induction motor.

In the field of electrical measuring instruments, he invented the "inclined-coil" instrument (1895) and the Thomson integrating wattmeter (1889). It is this latter meter which is now almost universally used for measuring amounts of electric power used. In 1890 this instrument was exhibited in Paris and a prize of 10,000 francs for meters was divided between Thomson and Aron.

He next turned to the investigation of high-frequency phenomena. Already he had conceived the notion (1876), as I have mentioned, of tuning electric circuits, an operation fundamental to modern communication systems, and he had observed the propagation of electrical waves through space. In 1890 he patented a dynamo operating at frequencies 30 to 40 times greater than any previous machine. This led him to design high-frequency transformers. While working in this field he discovered (1893) a method of producing still higher frequency alternating current from a direct current arc, by shunting the arc with inductance and capacity, thus discovering the method which played such an important role in wireless transmission up until its virtual replacement by electronic tube devices. This interesting method of producing alternating currents was independently developed and

[7] "Professor Thomson and the Development of the Lynn Electrical Industry," by J. A. McManus, Tercentenary edition "Greater Lynn," June, 1929, Lynn Chamber of Commerce.

applied to wireless telegraphy by Poulsen, and is therefore generally known as the Poulsen arc.

Among his many other electrical inventions should be noted his resistance electric furnace patented in 1894, and a dynamo-static machine (1900) by which it was possible to obtain high-frequency discharges suitable for vacuum-tube apparatus.

In the summer of 1858, when 5 years of age, Thomson had seen Donati's comet and in 1867 he witnessed spectacular meteor showers. These early observations prompted his abiding interest in astronomy. In later years he published nearly a score of papers on astronomical subjects ranging from discussions of zodiacal light to solar eclipses.

Still other scientific byways of Professor Thomson's interest were the earth sciences. He published on "The Nature and Origin of Volcanic Heat," and in his last appearance before the American Academy of Arts and Sciences in 1933, he read a paper on "The Krakatau Outbreak." The eruption of this volcano in Java occurred when he was a small boy in Philadelphia, and had incited the curiosity which he always exhibited. He had watched for evidences, in the brilliant sunsets, of the volcanic ash in the upper atmosphere and had, I am informed, recorded his observations. At a much later date he hired as a research assistant a survivor of the catastrophe and induced him to record his personal observations of the event.

With all this intensive activity, Professor Thomson lived a rich family life. He was married on May 1, 1884, to Mary L., daughter of Charles Peck of New Britain, Conn., and of this union there were four sons, Stuart, Roland D., Malcolm and Donald T. In 1916 Mrs. Thomson died, and on January 4, 1923, he was married to Clarissa, daughter of Theodore F. Hovey of Boston.

Behind all his astonishingly varied interests, stood a man who had complete faith in the efficacy of the scientific method, and who in all his activities, vocational and avocational, was a shining exemplar of the scientific spirit. Observation and experimental inquiry were his chief reliances; he apparently did not resort to the mathematical or analytical methods that most scientists and engineers use who tackle problems as complex as he solved. He was not, like Steinmetz, a gifted mathematician; he seemingly did not need to employ mathematical analysis because his teeming mind leapt to correct conclusions without it.

His powers of observation he carried into every walk of life, and no one could be with him for ten minutes without being impressed and stimulated by his perception and by his wide-ranging knowledge of natural phenomena. He could best be described by saying that he was a brilliant natural philosopher who was held in equally high esteem by practical engineers and by academic scientists.

I have spoken of his devotion to education. His long association with the Massachusetts Institute of Technology affords a specific example. He became a lecturer in electrical engineering at this institution in 1894, and from then until his death he maintained with it the closest sort of relationship. He was elected a life member of the corporation in 1898, was acting president from 1920 to 1923, and for many years was a member of the executive committee of the corporation. He likewise served Harvard University as a lecturer and as a member of several of its visiting committees.

In other ways he never ceased to teach. His friend, Dr. Richard C. Maclaurin, President of the Massachusetts Institute of Technology from 1909 to 1920, observed:

> Throughout his life he has not only done great things himself but shown an intense desire to help all who are struggling earnestly with scientific problems. He has proved an inspiration to an ever-widening circle of engineers and others who have intrusted him with their secrets and sought his help in overcoming their difficulties. They have done this, knowing that they had only to ask in order to get the full benefit of his imagination and his power, and that they need have no misgivings that he would take any advantage of their confidence or any credit for their work, for he has no touch of selfishness.

From my own association with him I can validate Dr. Maclaurin's tribute. He combined in a most remarkable way the constructive power of the inventor, the intuition and imagination of the great scientist and the kindly balance of the ideal philosopher, teacher and friend. His life encompassed the development of the electrical industry, and he will long be remembered as one of those who brilliantly extended and applied the primary discoveries of Faraday and the other pioneers in the science of electricity.

He died on March 13, 1937, in his eighty-fourth year.

GROUP ORGANIZATION AMONG VERTEBRATES[1]

By Professor W. C. ALLEE
THE UNIVERSITY OF CHICAGO

IN our laboratory and elsewhere, so far as we have found by gleaning through the literature, most stu-

[1] A shortened version of an illustrated lecture on this subject which was given as a part of the symposium on "Integration of Biological and Social Systems" at the recent Fiftieth Anniversary Celebration of the Univer-

dents of group organization in animals have been attracted to the subject primarily by the opportunity to study general and comparative sociology.

We have not been attempting an oblique attack upon group organizations of men; but while this is true, all of us who have worked with these problems have found our attention and curiosity caught by certain similarities between group organization in animals and some of the simpler phases of human society. Perhaps it will be such comparisons that will most interest the reader. I think it is wise for them to be made, providing that due restraint is exercised. In order to understand the integrations of human society we need to know how much is uniquely human and how much is, on the other hand, the specialized human development of a more generalized primate pattern, which derives from mammalian and lower vertebrate patterns which in turn are related to certain types of invertebrate social organization.

To be more specific, the social integrations of mice and hens, cattle, fish, frogs, lizards and turtles and many other animals have much in common with the organization of certain human groups. Without taking the comparisons too seriously, and leaving primary sex relations entirely aside, these similarities may help explain human social organizations; I would not say that the human social variant is justified either because it resembles or departs from the more generalized type.

The modern period in the study of social organization of groups of animals in which the individuals were in some way distinguished from each other was initiated by Schjelderup-Ebbe,[2] twenty years ago. A large descriptive literature has accumulated in this field and there has been a promising beginning of analytical work. Most of these studies have dealt with loosely caged flocks of various species of birds and the social order of the common domestic fowl has attracted particular attention. Reports of somewhat similar group organizations in nature are also beginning to appear.[3]

At Chicago we have been interested in these phenomena as one phase of the broad field of animal aggregations. We have studied the organization pattern in several different species of birds and in certain mammals, especially mice. The following discussion will be based mainly on the work at our own laboratory; not because it is most important, but because of our familiarity not alone with the results obtained but also with the observational and experimental errors and personal biases which may affect conclusions.

One of the most regular social hierarchies which we have observed is summarized in Table 1.

TABLE 1

THE SOCIAL ORDER IN A FLOCK OF WHITE LEGHORN HENS

Individual	Number pecked	Individuals pecked							
BB	8	RG	RR	GG	BR	YY	BY	GY	RW
RW	7	RG	RR	GG	BR	YY	BY	GY	–
GY	6	RG	RR	GG	BR	YY	BY	—	–
BY	5	RG	RR	GG	BR	YY	—	—	–
YY	4	RG	RR	GG	BR	—	—	—	–
BR	3	RG	RR	GG	—	—	—	—	–
GG	2	RG	RR	—	—	—	—	—	–
RR	1	RG	—	—	—	—	—	—	–
RG	0	—	—	—	—	—	—	—	–

Such a social order among birds is based on what has come to be called peck-right. The higher ranking individuals are able to peck those of lower rank without themselves being pecked in return. This right is usually won at the first or at least during one of the early pair contacts between each two adult members of the flock either as a result of an active fight or by passive submission of one of the members of the contact pair.

Often the flock is not so simply and regularly organized. One of the most frequent irregularities comes when a low-ranking hen has the peck-right over some individual that outranks her in general social position. Another fairly common complication occurs when triangle situations arise in which *a* pecks *b*, *b* pecks *c* and *c* pecks *a*, and then all have the peck-right over those lower in the social scale. There is not space here to suggest all such variations or to discuss what is known about their causation.

The organization in a flock of hens represents a type of social pattern in which dominance, once won, is relatively permanent. At least one other type of social structure also exists among birds. With pigeons, doves, canaries and shell parrakeets, for example, although the flock organization is no less real, the outcome of any given pair contact is less predictable. Such flocks are organized on what may be called peck-dominance rather than on the more absolute peck-right relations that exist among hens and certain other birds. As was discovered several years ago[4] and confirmed more than once,[5,6] the peck-dominance type of social order is related in part to territoriality in that certain birds are dominant in one territory and subservient in another.

All group organizations among birds are apparently based on the ability of birds to recognize and remember their flockmates as individuals. When territory enters as a factor, recognition of the indi-

sity of Chicago. A more nearly complete account will be published, together with the other papers in that symposium, in a forthcoming volume of "Biological Symposia."

[2] *Zeitschr. f. Psychol.*, 88: 225–252, 1922.

[3] E. P. Odum, *Auk*, 58: 322–323, 1941.

[4] R. H. Masure and W. C. Allee, *Auk*, 51: 306–325, 1934.

[5] H. H. Shoemaker, *Auk*, 56: 381–406, 1939.

[6] E. Diebschlag, *Zeitschr. f. Tierpsychol.*, 4: 173–188, 1941.

vidual's territory also becomes a part of the group reactions system. Shoemaker[5] has shown that the space available for a flock of canaries is a matter of importance. When they are confined in a relatively small space, the social order becomes relatively simple and definite; it is little complicated by territoriality. Given more space, individual territories tend to become established in which the territory holder is usually supreme, even though it ranks low when in the neutral ground about bath bowls, feeding trays and in the other areas of the canary public service system. Even a socially low-ranking male normally dominates other males in some restricted space about his nest.

In connection with the intermingling of territoriality and social dominance, there are available many unpublished observations made locally by Mr. Dale Jenkins and Mrs. Barbara Hale Brainerd which show that a family of blue geese, as a family, dominated pairs and single individuals of ducks and geese during the winter months, and defended the territory about themselves wherever they might be, on land or in the water. The defended territory was not precisely located, but moved with the dominant family.

When there is a recognition both of individuals and of territory it is impossible as yet to separate the two. In such cases the question concerns the extent to which the individual plus his territory is the unit in the flock organization, as contrasted with either the individual or the territory as the basic unit.

What are the long-run biological effects of group organization at the level of which we are speaking? And what are the known factors that make for dominance? Our observations on flocks of chickens and other birds and on groups of other animals throw some light on these questions.

As to the first: The results of the fact that the highest-ranking hens lead the freest lives and low-ranking ones are harassed can be shown, among other ways, by studies on egg production. Hens from the lower half of the peck-order lay fewer eggs than their more dominant sisters, even when both come from the same genetic strains.[7] The egg-laying performance of the submissive hens can be much increased by segregating them from their domineering sisters. This is half of the story.

The other half is concerned with the relation between the peck-order among hens and mating behavior. Mr. Alphaeus Guhl, of the University of Chicago, has kindly allowed me to make a preliminary announcement concerning some of his unpublished work on this subject. He has had experience with several cocks placed successively or in groups of four with different flocks of hens, and has found practically no correlation between frequency of copulation and the social status of the hen.

Mr. Guhl also determined the peck-order in different groups of cocks; again there was no significant relationship between the social standing of the cock in relation to his fellows and the frequency of his mating when introduced alone into a flock of hens who were well accustomed to his presence.

When, however, the four cocks of a given flock were all placed together in an uncrowded pen of hens, there developed a type of psychological castration of the low-ranking males which, in some individuals, became practically complete. The details of the whole complicated story have much interest. I can take space for only one example.

The cock Y stood second to R in the peck-order of the males. Y was sexually aggressive and successful in a rough, forceful way when he was alone with the hens. When the four cocks and seven hens were placed together, the *alpha* cock R would charge at Y and drive him to the roosts whenever Y approached the hens. Meantime the hens would all scatter and fly to any available perch. Y soon learned to spend less and less time on the floor and the hens learned to run when he came down to feed. Y lost weight during this period and his food hunger increased. For practical purposes Y was no longer sexually effective.

Interestingly enough, these birds show what we can call favoritism as well as antagonism. Thus the dominant R did not similarly persecute cock G but even allowed him to interfere with R's own courting, and that without punishment.

When Y was placed with another flock of hens he was uninhibited sexually. Placing cocks with strange flocks is known to increase their sexual activity. However, later, when Y was again placed alone with the hens that he had been conditioned not to tread, not only did he attempt to copulate less frequently than before he was psychologically castrated, but it was also found that the hens had been conditioned against allowing him to tread them.

Conditions such as I have been reviewing indicate that social position in the flock may affect the opportunity of a given male or female for leaving numerous offspring. Those high in their respective peck-orders have the better opportunity for becoming parents of the next generation, as a result of the hen's greater freedom for egg production and of the cock's freedom for copulation.

So much for individual selection as a result of social status. There is a still more important problem in selection to be outlined. Is an organized group sufficiently different from an unorganized one at this level so that selection of the whole lot can occur?

[7] W. C. Sanctuary, Master's thesis deposited in the library of Massachusetts State College, Amherst, Mass., 1932.

We are coming to realize that groups of animals and other more-or-less integrated population units can be selected somewhat as though they were individuals. In fact, some of us think that natural selection of such populations, rather than natural selection of individuals, is the important basis of evolution. There is no experimental evidence with regard to the selection of organized as contrasted with unorganized groups. I believe the problem is open to experimental attack and if we had had space available, such an attack would have been under way.

We shall turn from this to consider some of the factors that make for social dominance. Dominance-subordination patterns of behavior may be based on the recognition of other members of the flock as individuals to which a proper reaction must be made. This is the method which obtains in many social groups of men, and in all the flocks of birds which we have studied. Opposed to this is a type of impersonal behavior pattern such as is found in many of the groups of mice which have been studied in our laboratory, especially by Dr. Uhrich[8] and Mr. Benson Ginsburg. Impersonal group organization depends upon a kind of unoriented, generalized aggressiveness brought in contact with similarly unoriented lack of aggressiveness. This is a type of statistical relationship in which a very bellicose animal dominates its own or foreign groups as a result of his high degree of bellicosity. A dominance-subordination system of behavior with such a basis does not represent the same social mechanism as does one which depends on individual recognition, although the two systems may be related.

Small lots of male mice caged together develop a social order as just suggested which is based on relative aggressiveness and general fighting ability. The order is not as stable as that found among hens, but it is sufficiently stable to allow experimentation when this is carefully controlled.

In the work with hens and in early work with mice, there had been suggestions that a succession of victories tended to condition the individual to be victorious in the next contest, while a series of defeats had the opposite effect. Mr. Ginsburg and I turned to mice in order to make a direct test of this interesting lead.

The ease of experimentation was made greater by the discovery by Dr. J. P. Scott[9] of hereditary strains of highly inbred mice which differed decidedly in fighting tendencies and abilities.[10] Roughly speaking, we had available a belligerent strain which was black in color; a strain of pacific mice bearing white coats, and an intermediate agouti strain which generally lost to the blacks and usually won from the whites.

These differences in fighting prowess made it possible to expose a high-ranking mouse from the passive white strain to repeated defeats from the belligerent blacks, and then test the effects of such experience by again staging intra-strain combats among the white mice. Or, on the other hand, an attempt could be made to "build up" a low-ranking brown or black mouse by repeated contacts with the submissive whites.

After some 60 fights among themselves, W 1 emerged as the dominant mouse of a group of five white males, and held that status during the next 140 fights. Since this order seemed to be stable, the time was ripe for experimentation. Accordingly, W 1 was matched with B 2, the *alpha* mouse of the aggressive blacks, twice a day for eight days. B 2 attacked aggressively even when W 1 was entirely passive. When again matched with his fellow whites, W 1 submitted to every opponent, including even the very passive *omega* white mouse. After some 180 fights among themselves, W 1 regained aggressiveness and again became dominant over the white mice. Even so, he remained passive when matched against even the least aggressive of the belligerent blacks.

Our experience with other mice indicates that if W 1 had met more active resistance from its own group, it would probably have been even slower to reassume aggressiveness. In fact, when W 2 was similarly conditioned downward and then returned to face the other white mice, it was attacked by the dominant W 1 and showed a submissive attitude toward all, until after a series of mild encounters with the *omega* mouse of these pacific whites it again became somewhat aggressive.

It is much easier to cause an intermediate mouse to lose social status by repeated defeats than it is to do the same with a dominant individual. Such an intermediate animal has already been partly conditioned toward submission as a result of losses to the more dominant members of its own group. When intermediate mice were conditioned downward and then kept from meeting dominant mice in their own group they recovered social confidence just as a dominant individual does under similar conditions.

The dominant white mouse, W 1, was given a longer and more severe experience with repeated defeats. As a result he became so passive that he showed no resistance whatever, and throughout the ensuing two months, he was submissive to all the members of the group which he had formerly dominated. For a time he gave the submissive reaction whenever another mouse came near him; later, only when he was actively threatened. He continued, however, to give up immediately in the face of any show of aggressiveness

[8] J. Uhrich, *Jour. Comp. Psychol.*, 25: 373–413, 1938.
[9] J. P. Scott, *Anat. Rec.*, 78: No. 4. Supp., 1940.
[10] I am indebted to the Jackson Memorial Laboratory for the gift of these mice.

in another mouse. He regained aggressiveness after being isolated for four months.

Generalizing from a considerable extent of such experience, we have found that it is relatively easy to condition a mouse downward in its social scale, and that the longer and more severe the conditioning, the more lasting the results. We have found that it is also possible to so train a less aggressive mouse that it will become more dominant. This can be done even with low-ranking mice in the most pacific strain. But while it is possible, it is difficult to arrange social contacts such that a mouse at the very bottom of the group organization will show increased social aggressiveness. The training toward aggressiveness goes exceedingly slowly and must be modified to meet the nuances in the behavior of each individual. As in causing mice to lose social status, it is much easier to train intermediate mice to be aggressive than those which are low in the social scale.

One example must suffice. I choose this particular case since we have a motion picture record of the final battle of such a long conditioning series.

Br 6 was at the bottom of the social order among the agouti mice. He was almost completely non-aggressive. Finally Br 6 was mated; and low-ranking, passive white mice were introduced into his home cage. Br 6 had never before made an attack, but now, in the presence of his mate, he threatened and fought off the mild invaders. Even this show of aggressiveness did not carry over in the absence of a female, and it took six weeks of careful social manipulation combined with a judicious use of isolation, which in these mice helps to build aggressiveness, before Br 6 finally attacked one of the whites when the two were alone together in a neutral cage. After this he was made to encounter several low-ranking whites daily in the fighting cage, and as a result of the total build-up he became definitely aggressive.

The extent of his aggressiveness is indicated by the fact that within an hour after a defeat by B 1, the fightingest mouse we had, he vigorously counterattacked and defeated his immediate superior in the social scale among the agoutis. He also won from other superiors after we had taken the precaution to have these fights staged soon after the latter had been defeated.

Meantime we wanted a good hard fight for the motion picture record. B 2, the dominant black, had just suffered two of his rare defeats and was nursing a lacerated shoulder. Even so, he was an aggressive, hard-fighting mouse. Somewhat optimistically we matched Br 6 against him. It is fortunate that we have a visual record of one of the most decisive inter-strain combats seen in this laboratory. Br 6 lost but only after fighting so hard that he died a few minutes later. There can be little question of the efficiency of the upward conditioning in this case.

And now a few final paragraphs. The socially dominant animals we have been discussing may or may not be the leaders in their groups. The *alpha* hen in a penned flock does not necessarily lead in foraging expeditions when the hens are turned out into an open lot. In fact, in such a foraging flock leadership changes frequently and the bird at the apex seems always more or less dependent on her followers. With certain other birds, in the flying flocks of which the different individuals can be recognized, the one in front is at times merely the fastest bird in the flock. So far as true leadership is concerned, it is only following along ahead of the main flock. A somewhat similar relationship between leader and followers has been observed among other animals, notably with ants and with men.

In the female herd of cows the dominant animal is the leader. With certain species of deer the female also leads, even when males are present; with other species the male is the leader.

The final point I have to make is a disappointingly negative one: I have said that group organization with a dominance-subordination pattern occurs among a wide variety of vertebrate animals, but the bearing of these patterns on leadership is another matter. While we now know how to study the problem of leadership in an objective and comprehensive way, actually very little progress has been made in such studies upon non-primate animals.

We do know, from experimental analysis, that the dominance-subordination pattern of group behavior may be influenced by environmental factors and may have its foundations in (a) heredity, as shown by different degrees of aggressiveness in different genetic strains; (b) in the physiological state of the individual, one phase of which is illustrated by studies on the hormonal control of dominance; and (c) on experience which with hens and mice may be recent, or remembered from the relatively remote past.

OBITUARY

JOHN ALEXANDER McGEOCH

In the prime of his career, occupying a position of leadership in American psychology, the life of Professor McGeoch was cut short by his untimely death in Iowa City on March 3, 1942. He died of a cerebral hemorrhage after a short illness.

Professor McGeoch was born in Argyle, New York, October 9, 1897. He received his A.B. degree from

Westminster College in 1918 and his M.A. degree from Colorado College in 1919. He received his Ph.D. from the University of Chicago in 1926, after having done part of his graduate study at the University of California and at Columbia University. In 1924 he married Grace Oberschelp, who died in 1927; and in 1939 he married Mrs. Frances Hady, who with her two children, and his mother, Mrs. Alexander McGeoch, survive him.

He came to Iowa as head of the department of psychology in the fall of 1939, and while here he has won high recognition for his scholarly activities in the pursuit and promotion of research, his excellence in teaching and administrative activities, his good judgment and winsome personality, and his trustworthy leadership in the department and in the university as a whole. His researches have centered around problems in the psychology of learning. He had just completed his magnum opus, a volume entitled "The Psychology of Human Learning," which is being published by Longmans, Green. He has served as editor of the *Psychological Bulletin* since 1935, and has published a number of papers, principally in the field of experimental psychology in education.

Professor McGeoch has been active in the American Psychological Association, the American Association for the Advancement of Science (secretary, Section I, 1934–1936), the Eastern Psychological Association, the Midwestern Psychological Association (secretary-treasurer, 1932–1934; president, 1935), the Society of Experimental Psychologists, the Southern Society for Philosophy and Psychology, and the National Institute of Psychology (president, 1941). He was a member of Sigma Xi, Phi Beta Kappa, Phi Delta Kappa and Phi Sigma. He served as instructor of psychology at Washington University, 1920–1922; assistant professor, 1922–1926; and associate professor, 1926–1928; professor of psychology, University of Arkansas, 1928–1930; professor and chairman of the department of psychology, University of Missouri, 1930–1935; research professor, Wesleyan University, 1935–1939, which position he left to come to the University of Iowa.

CARL E. SEASHORE
THE STATE UNIVERSITY OF IOWA

RECENT DEATHS

SIR WILLIAM BRAGG, Fullerian professor of chemistry and director of the Royal Institution, London; director of the Davy-Faraday Research Laboratory; from 1935 to 1940 president of the Royal Society, died on March 13 in his eightieth year.

DR. ROBERT WILLIAM HEGNER, professor of protozoology and head of the department of medical zoology at the Johns Hopkins University, died on March 11 at the age of sixty-two years.

DR. KARL MCKAY WIEGAND, professor emeritus of botany, formerly head of the department at the New York State College of Agriculture at Cornell University, died on March 12 at the age of sixty-eight years.

DR. ROBERT WILSON SMITH, professor emeritus of biology, McMaster University, Hamilton, Ontario, died on February 22, in his eighty-second year.

SCIENTIFIC EVENTS

THE ROYAL OBSERVATORY AT THE CAPE OF GOOD HOPE[1]

THE report for 1940 of H.M. Astronomer at the Cape of Good Hope illustrates how astronomical work in the belligerent countries is being affected even though they may be far removed from the present scene of hostilities. Half the observing staff at the Cape is now engaged on non-astronomical duties, this at a time when so many observatories in Europe have perforce suspended work. Nevertheless, the depleted staff is doing its best to secure such observations as can not be replaced by any made at a later date. Meridian observations of the moon have been started in view of the possible loss of European observations, and volunteers have come to the rescue in observing occultations. Photographic work has been somewhat precarious owing to delays in the delivery of plates, but few photographs have been lost, and the position has been eased by a modification of the program of routine solar observations which supplements that still being carried on at Greenwich. Work on the Reversible Transit Circle continues on a somewhat reduced scale, and the photometric observations are now sufficiently far advanced to make possible the construction of a framework of stars of magnitudes between 7 and 10 to which the magnitudes of the zone stars can be referred. With the 1940 batch of parallaxes the observatory now enters the very restricted list of stations at which the distances of more than a thousand stars have been determined trigonometrically.

The section of the report which will be read with perhaps the greatest interest concerns the total solar eclipse of October 1, 1940. The main part of the program was to measure the gravitational deflection of light in the sun's field—the Einstein effect. The Greenwich expedition which was to have cooperated in this work was cancelled at the outbreak of war, and the entire program was carried through, as planned, by the Cape staff. It is disappointing to

[1] From *Nature*.

have to record total failure in this part of the work. The field of stars close to the eclipsed sun was known beforehand to be a poor one; but eclipses are so few and far between that the attempt seemed justified. In fact, the lessened exposure time and reduced aperture necessary to prevent fogging of the plates by the rather bright sky, combined with the poor daytime "seeing" on the Karroo to prevent any stars showing on the negatives at all. Astronomers all over the world will sympathize with H.M. Astronomer and his staff in this disappointment, particularly as observing conditions were otherwise good. Their sole compensation was in securing the only large-scale photographs of the corona obtained during this eclipse —photographs which, though interesting and indeed important, represent a most inadequate reward for months of work.

NEW KODACHROME SLIDE SERIES OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE department of education of the American Museum of Natural History has made available to schools and colleges the first teaching series of kodachrome lantern slides to be offered by any institution. The "Evolution of the Horse" is the title of this set of twenty-five slides made up in the 2×2 inch size.

The late Dr. Walter Granger, paleontologist at the American Museum, endorsed the accuracy of the slides which are reproductions of exhibits in the museum.

A process of duplicating kodachrome pictures has been developed by the museum, so that careful control of the color of the final slide is maintained. The original photographs of the exhibits are made on the larger kodachrome sizes so as to retain as much detail as possible. These large pictures are then rephotographed down to the thirty-five millimeter size using an artificial light source accurately adjusted as to color temperature. A complete series of faint complementary color correction filters makes it possible to adjust the hues of the final slides to as close a duplicate of the original colors in the museum exhibits as is necessary to maintain fidelity.

The "Evolution of the Horse" series contains maps of the chief fossil deposits in the United States, pictures of the formations in which the fossils are found, a progressive series of the fossil horse skeletons, Charles R. Knight's paintings of restorations of the fossil horses and the contemporary life of each period. Slides comparing the skulls, hooves and overall size of the earliest and modern horses complete this series. A special manuscript has been written describing the slides and the story of "The Evolution of the Horse."

This set of slides is the first of several that are planned. The Story of the Dinosaur and Ancient Man will follow soon. The "Evolution of the Horse" is already in use in the high schools of New York City.

FOREST FIRE PROTECTION

THE American Forestry Association, in an open letter to the Congress, urges that forest fire protection be placed on a war-time basis. Shortage of employable labor in the forest regions because of military service and demands of war industries, coupled with the curtailment and diversion of the CCC, heretofore an important link in forest fire protection, were given as reasons for the growing fire peril to vital timber resources.

Recommendations that a war priority rating be given forest protection and that the CCC be reappraised in the light of a streamlined, mobile resource protection force with the status of an essential war agency were made by the association.

Back of these recommendations is the important fact that forest resources are now being heavily drawn on and must continue to be heavily drawn on in the prosecution of the war. According to the association, the war already has called for 2,500,000,000 feet of lumber from the nation's forests, and the War Department has let contracts for upwards of a billion feet more. Wood is needed in great volume for airplanes, cargo and fighting ships, construction of training camps and cantonments, crates for shipping food and equipment to the battle fronts, and scores of other war-needed products. Protection of such a vital war resource is an immediate and major concern to the Congress and to the nation. It is pointed out in the letter to the Congress that

> Failure to make provision to assure adequate protection of these resources during seasons of the year when it is known they will be exposed to critical danger, may easily disrupt and delay our all-out plans to win this war. Forest fires do not wait for man to organize after the fire season arrives. They can be dealt with successfully only by advance organization, planning and preparedness. The question as it now presents itself appears to be primarily one of providing necessary man power in advance through centralized governmental action instead of leaving it to regional protective agencies to compete with one another for labor and to be short-handed and unprepared when critical forest fires break out.

COMMITTEE OF EXAMINATIONS AND TESTS OF THE AMERICAN CHEMICAL SOCIETY

THE Committee of Examinations and Tests, Division of Chemical Education, of the American Chemical Society, has announced that the 1942 Cooperative Chemistry Test will be available by April 1. Inquiries

should be addressed to the Cooperative Test Service, 15 Amsterdam Avenue, New York City.

The accumulation of data and experience of the past six years has had the effect of modifying the concept of what a test should measure and how this should be accomplished. As a result of extensive discussion at a conference, held at the University of Chicago last June, the 1942 form of the test is considerably different from the tests of the past four years. The test has been administered in a preliminary form to determine the difficulty and validity of each item, and the committee hopes for its wide-spread adoption. A brief description of the test follows:

Part I. General Knowledge and Information.

This section is based on knowledge of our acquaintance with important facts, definitions, laws and theories of chemistry. Historical events and application of chemistry to the social and economic world are represented.

Part II. Application of Principles.

This part attempts to measure the ability to solve numerical problems, to balance equations and to make quantitative predictions by the application of chemical principles.

Part III. Scientific Method.

This section is concerned with the understanding of the relation of observation, definitions, laws, theories in the scientific procedure. The relation of theory to experiment is represented, as well as the ability to interpret chemical data.

Part IV. Knowledge of Laboratory Technic and Procedure.

This new section is included in the effort to measure acquaintance with the laboratory and knowledge of "correct" procedures. It does not attempt to measure skill or technic *per se*.

The committee which is sponsoring the test is comprised of the following members of the Division of Chemical Education:

B. Clifford Hendricks, University of Nebraska; Rufus D. Reed, New Jersey State Teachers College; Ed. F. Degering, Purdue University; Laurence S. Foster, Brown University; Earl W. Phelan, Georgia State Womans College; Theodore A. Ashford, University of Chicago, and Otto M. Smith, Oklahoma Agricultural and Mechanical College, *chairman*.

AMERICAN STANDARDS FOR 1942

The American Standards Association has announced the publication of its new list of American Standards for 1942. This announcement points out that in view of the importance of standards and specifications, not only for every-day work but to speed up production for defense, this particular list of standards should be in the hands of the engineering and purchasing departments of every manufacturing firm in the United States.

Nearly 500 American Standards are listed in a wide variety of industrial fields and in the fields of industrial and public safety. There is a separate heading for American Defense Emergency Standards—standards developed specifically for defense purposes, and for the first time all American Safety Standards are listed together in a separate section.

The standards include definitions of technical terms, specifications for metals and other materials, methods of test for the finished product, dimensions, safety provisions for the use of machinery and methods of work. They reach into every important engineering field, serving as a basis for many municipal, state and federal regulations.

In each case these standards represent general agreement on the part of maker, seller and user groups as to the best current industrial practice. More than 600 organizations are taking part in this work. The standards are frequently reviewed and revised in order to keep them in line with changing industrial needs. New standards, and those brought up to date within the year, are especially marked in the list.

The list will be sent free of charge to any one writing in for it. Requests should be addressed to the American Standards Association, 29 West 39th Street, New York, N. Y.

WAR WORK OF THE DEPARTMENT OF PSYCHOLOGY OF YALE UNIVERSITY

The following members of the department of psychology of Yale University are working full- or part-time in work in connection with the war:

Leonard W. Doob, social psychologist who is on leave of absence from the university, is employed now with the Office for Emergency Management in Washington. He is in charge of the analysis section of the Office of the Coordinator of Inter-American Affairs, under Nelson Rockefeller. In this capacity, he supervises a staff in the analysis of public opinion in Latin American republics and Axis propaganda directed at them. He also analyzes the effects of American activities in this respect and makes recommendations to all divisions of the office on the basis of his findings. Doob is the author of "Propaganda."

Neal E. Miller has recently been granted a leave of absence to accept a commission in the Army Air Force, where he is engaged in the pilot selection program and in research on problems of emotional adjustments in aviators.

Judson S. Brown, instructor in psychology, has been commissioned first lieutenant in the Army Air Corps and will be engaged in psychological research under the direction of Colonel Harry G. Armstrong.

Several members of the department, including Mark A. May, Neal E. Miller, Judson S. Brown and Robert R. Sears have been engaged in New Haven in the Air Raid Warden Training Program giving addresses on the prevention of panic.

Walter R. Miles, professor of psychology, is a member

of the National Research Council, studying aviation medicine, sound control in vehicles, aircraft pilot selection and training and night vision. He is chairman of its Emergency Committee in Psychology. He is also chairman of the National Research Council Committee on Problems of Neurotic Behavior.

Robert M. Yerkes, professor of psychobiology, is expert consultant to the War Department and a member of the National Research Council's Emergency Committee in Psychology.

Carl I. Hovland, assistant professor, is co-author of the intelligence tests used by the Navy Air Corps in selecting candidates. He is unofficial adviser and consultant in aviation testing both in this country and in Canada. In addition, under the auspices of the War Production Board, Hovland is statistician and industrial psychologist for a group studying working arrangements in war industries. He has recently been appointed expert consultant to the Secretary of War.

THE AMERICAN SOCIETY OF NATURALISTS

AT the recent Dallas meeting of the American Society of Naturalists, officers were elected as follows: Dr. Ralph E. Cleland, professor of biology and chairman of the department, Indiana University, *president;* Dr. L. C. Dunn, professor of zoology, Columbia University, *vice-president* for the next year, and Dr. Malcolm R. Irwin, professor of genetics, College of Agriculture, University of Wisconsin, *treasurer* for three years. Dr. A. C. Kinsey, Indiana University, continues as secretary for a period of three years.

At the same meeting, the following persons were elected members of the society on account of outstanding achievement in biological research:

B. G. Anderson, Western Reserve; P. B. Armstrong, Syracuse, L. G. Barth, Columbia; F. A. Beach, American Museum of Natural History; Charles M. Breder, Jr., New York Aquarium and American Museum; J. W. Buchanan, Northwestern; W. Burrows, Chicago; D. P. Costello, North Carolina; J. N. Couch, North Carolina; P. S. Galtsoff, U. S. Bureau of Fisheries; V. Hamburger, Washington; A. Hollaender, U. S. Public Health Service; Clay G. Huff, Chicago; Libbie H. Hyman, American Museum of Natural History; George W. Kidder, Brown; L. H. Leonian, West Virginia; Howard S. Liddell, Cornell; N. E. McIndoo, U. S. Bureau of Entomology; Clarence P. Oliver, Minnesota; Roberts Rugh, New York; F. O. Schmitt, Washington; G. L. Stebbins, Jr., California; Ivon R. Taylor, Brown; H. B. Tukey, Cornell; B. W. Wells, North Carolina State College; E. T. Wherry, Pennsylvania; D. M. Whitaker, Stanford; Truman G. Yuncker, De Pauw.

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM J. GIES, professor emeritus of biochemistry at Columbia University, was the recipient on his seventieth birthday on February 21 of congratulatory messages from dental organizations throughout the nation. Dr. Gies was the organizer of the International Association for Dental Research, founder of the *Journal of Dental Research,* director of the Carnegie Foundation Study of Dental Education in the United States and Canada and a leader in the organization of the American Association of Dental Schools.

A LIFE fellowship in the Thomas A. Edison Foundation for the Advancement of Science and Education has been conferred upon Dr. Robert Gordon Sproul, president of the University of California. The award is given to "only a few outstanding Americans in the fields of medicine, science, art and education, who have made some real contribution to human welfare."

THE 1942 Hillebrand Award of the Washington, D. C., Section of the American Chemical Society was presented to Dr. Michael X. Sullivan, director of the Chemo-Medical Research Institute of Georgetown University, in recognition of his work in measuring important chemical constituents in living organisms. The presentation ceremony was held on March 12 at the Cosmos Club, Washington, D. C.

THE three hundred and eleventh meeting of the Washington Academy of Sciences was held on March 19 at the Cosmos Club. The meeting was devoted to the presentation by the academy of its awards for scientific achievement for 1941. These are: For the *Biological Sciences,* G. Arthur Cooper, U. S. National Museum, "in recognition of his distinguished service in invertebrate paleontology, notably for his discovery of anatomical structures hitherto unknown"; for the *Engineering Sciences,* Theodore R. Gilliland, National Bureau of Standards, "in recognition of his distinguished service in originating automatic ionosphere recordings of continuously variable radio frequencies"; for the *Physical Sciences,* Sterling B. Hendricks, U. S. Bureau of Plant Industry, "in recognition of his distinguished service in determining the constitution of micaceous and other complex minerals."

AT the annual dinner in New York on March 13 of the Society of Automotive Engineers, the Wright Brothers Medal was awarded for last year's "outstanding contribution to aeronautical knowledge" to Samuel J. Loring, vibration engineer for the Vought-Sikorsky division of United Aircraft. Dr. J. C. Hunsaker, chairman of the National Advisory Committee for Aeronautics, presented the award to Mr. Loring, whose paper on high-speed flutter in aircraft was read before the society a year ago.

DR. H. DE FOREST was the guest of honor at a dinner given recently by the Botany Club and Phi Sigma, honorary biological fraternity, to celebrate his twenty years of service at the University of Southern California. He was presented with a radio set.

DR. JOHN HARVEY KELLOGG, since 1876 medical director and surgeon of the Battle Creek Sanitarium; founder and medical director of the Miami-Battle Creek Sanitarium; founder and president-emeritus of Battle Creek College, was the guest of honor on February 26 at a dinner given by the Battle Creek chamber of commerce and the county medical society. An inscribed scroll was presented to him.

AT the Dallas meeting of the American Society of Zoologists the following officers were elected: *President,* L. L. Woodruff, Yale University; *Vice-president,* C. G. Hartman, University of Illinois; *Secretary,* L. V. Domm, University of Chicago; and *Treasurer,* H. W. Beams, State University of Iowa.

THE Columbia University Chapter of Sigma Xi has elected Dr. Victor K. LaMer, professor of chemistry, to succeed Dr. Selig Hecht as president of the society. Professor Jan Schilt, head of the department of astronomy, has been elected vice-president.

DR. DAVID BRUNT, professor of meteorology at the Imperial College of Science and Technology, London, has been elected president of the Royal Meteorological Society.

DR. PETER FRANDSEN, professor of zoology and bacteriology and head of the department of biology of the University of Nevada, for forty-one years a member of the faculty, will retire at the close of the academic year.

DR. LOUIS M. HEIL, research associate in science at the University of Chicago, has been made head of the department of physics at Cooper Union with the rank of full professor. He will succeed Professor Albert Ball, who retires on June 30 after thirty-seven years of service.

DR. OTTO LOEWI, Nobel laureate and research professor of pharmacology at New York University, will be at the University of Washington in Seattle for the spring quarter. He will conduct a series of weekly seminars on Tuesday evenings, beginning on April 28, on autonomic drugs, the sensitivity of denervated organs, the chemical determination of the nervous impulses and related topics. Four public lectures are also planned covering the general aspects of the chemical mediation of nervous activity, regulation of the organism and drug action and drug activity.

DR. H. C. SHERMAN, Mitchill professor of chemistry and head of the department at Columbia University, has been appointed vice-chairman of the Food and Nutrition Board of the National Research Council and a member of its executive committee and of its standing committee on research.

DR. WALDO SHUMWAY, professor of zoology in the University of Illinois, has been called to field duty in the U. S. Army as a major of infantry. From 1917 to 1919 he served as a first lieutenant in the 103d Infantry, A. E. F.

PROFESSOR C. K. LEITH, of the University of Wisconsin, at present adviser to the Materials Division of the U. S. War Production Board, has been giving a series of ten lectures under the auspices of the division of geology and geography of Columbia University, entitled "Minerals in Peace and War."

DR. JAMES S. MCLESTER, professor of medicine at the School of Medicine of the University of Alabama and past president of the American Medical Association, will deliver the Hermann M. Biggs Memorial Lecture at the New York Academy of Medicine on April 2. He will speak on "Nutrition and the Nation at War."

DR. PAUL R. HEYL, of the National Bureau of Standards, spoke on March 14 before the Philosophical Society of Washington. His address was entitled "A New Determination of the Constant of Gravitation."

DR. H. A. BETHE, professor of physics at Cornell University, is delivering Sigma Xi lectures at the following institutions: Washington and Jefferson College, Swarthmore College, North Carolina State College, Brown University, Western Reserve University and the Illinois Institute of Technology.

DR. MARION HINES, associate professor of anatomy at the Johns Hopkins Medical School, gave the Howe Lecture of Ophthalmology on March 17 at the Harvard Medical School. The subject of the lecture was "Recent Contributions to the Localization of Vision within the Central Nervous System."

THE annual meeting of the Division of Anthropology and Psychology of the National Research Council will be held in Washington on Saturday, April 25.

THE Kentucky Academy of Science will hold its twenty-ninth annual meeting at the University of Kentucky on April 10 and 11, with divisional groups holding sectional meetings. These groups will include the Kentucky branch of the Society of American Bacteriologists; the divisions of biology, chemistry, mathematics, physics, psychology and philosophy, and the Kentucky Geological Society.

A CONFERENCE on "Color, Constitution and Reactions of Dyes" will be held at the American Museum of Natural History on March 27 and 28 by the Section

of Physics and Chemistry of the New York Academy of Sciences. There will be an informal subscription dinner on Friday evening.

THREE chapters of the Society of the Sigma Xi, the national honorary society for the promotion of research in science, are being installed during March. The Utah State Chapter was formally installed at the Utah State Agricultural College, Logan, on March 14. After a convocation in the morning and formal installation ceremonies in the afternoon, there was a dinner, followed by an address on "The Structure of Liquids," by Dr. John G. Kirkwood, professor of chemistry at Cornell University. A chapter at the Louisiana State University, at Baton Rouge, will be installed with appropriate ceremonies on March 24. At the Illinois Institute of Technology, Chicago, a new chapter will be installed on March 25, with Dr. Ross A. Gortner, professor of agricultural biochemistry at the University of Minnesota, and Dr. George A. Baitsell, of Yale University, national secretary, as the installing officers.

THE Committee on Scientific Research of the American Medical Association invites applications for grants in support of researches on problems more or less closely connected with clinical medicine and public health. For information address the committee at 535 N. Dearborn Street, Chicago, Ill.

A UNITED PRESS dispatch, dated from Chicago on February 15, states that the Council on Medical Education and Hospitals of the American Medical Association has dropped the Medical School of the University of Georgia from its list of approved schools. A resolution to this effect was adopted at a business meeting and was signed by the chairman of the council, Dr. Ray Lyman Wilbur, president of Stanford University. In sending copies of the resolution to the chancellor of the university and the dean of the medical school, it is pointed out that its action was "without prejudice to students now enrolled." It was said informally that the action of the council expressed the disapproval of the dismissal of several members of the faculty after Governor Eugene Talmadge accused them of advocating "race equality."

IT is stated in *Museum News* that the committee on education and participation in science of the American Philosophical Society, Philadelphia, terminated its work on February 2. Plans of W. Stephen Thomas, executive secretary of the committee, to enter military service determined the committee's action in bringing the enterprise to a close. Mr. Thomas, who was formerly in charge of the educational department of the Academy of Natural Sciences of Philadelphia, had carried the burden of the enterprise from its beginning in 1939. The committee, under the chairmanship of Dr. Edwin G. Conklin, executive vice-president of the American Philosophical Society, undertook a survey of adult education in science in the Philadelphia region and the promotion of participation of adults in discussion forums, laboratory courses, museum tours, field trips, research in science and other activities. The organization of the Philadelphia Council of Amateur Scientists was an outgrowth of the committee's work. The committee published a monthly circular of activities in science in the region.

THE second National Chemical Exposition sponsored by the Chicago Section of the American Chemical Society, will be held from November 17 to 22 at the Stevens Hotel in Chicago. It is reported that more than 60 per cent. of available exhibition space, double the area of the first exhibit held in December, 1940, is already under contract with leading firms throughout the country. Victor Conquest, director of research for Armour and Company, is chairman of the committee in charge of a National Industrial Chemical Conference to be held in conjunction with the exposition, the program for which is now being arranged. It will be addressed by leaders in the chemical industry. It is announced that many scientific societies are planning to hold their meetings in Chicago during the period of the exposition.

IN reply to a telegraphed request from the National Safety Council for cooperation in President Roosevelt's war against accidents, the American Standards Association has made public the following statement: "The American Standards Association, the national standardizing body in the United States, whose membership consists of leading industries, most of the departments and administrations of the Federal Government and the leading technical organizations of the country, including the National Safety Council, offers its complete cooperation in the effort of the council to comply with President Roosevelt's request that it lead a campaign against accidents of all kinds that are hampering the National Defense Program. The development of national safety standards prescribing methods of removing accident hazards and conducting processes in a safe manner is essential to any nation-wide accident prevention campaign and has long been a most important part of the American Standards Association national standardization program. The sixty standards already developed will enable the council to present recommendations to the groups contacted in the campaign. An Emergency Procedure for the development of standards essential to national defense has been established by this association. This and other facilities of the association are offered for use in your campaign."

DISCUSSION

INSECTS AND EPIDEMIOLOGY OF POLIOMYELITIS*

IN SCIENCE for February 13, Professor Charles T. Brues discussed our report on flies as carriers of poliomyelitis virus[1] and probably expressed the feeling of many entomologists when he referred to our description of the insects as "naively vague" although he was kind enough to add "for an otherwise carefully executed experiment." The purpose of this communication is to remove some of this "naive vagueness" by reporting certain data which have come to light since the publication of our original note, and to comment on the possible role of insects in the epidemiology of poliomyelitis.

When it is recalled that at the beginning of our experiments there was no valid evidence of the existence in nature of non-human carriers of poliomyelitis virus, it will not be difficult to understand why in the first tests we included all insects found in our traps even the caterpillar, "four-winged insect," moth and bee. The first part of the job was to determine whether insects are carriers and the second part, which ones. By this time we have been able to demonstrate the presence of poliomyelitis virus in 8 of the 15 batches of flies trapped during outbreaks of the disease in Atlanta and Cleveland. If we had tested relatively large quantities of the stools of 15 patients during the acute stage of poliomyelitis we could not have expected a very much higher incidence of positive results. And yet it is worth noting that, with one exception, the positive results we obtained were with insects that were not caught in the vicinity of privies. Our patients had been in the hospital for days or weeks and the other probable virus carriers in the city homes used good toilets. Where these insects got their virus is one of the intriguing problems for the future.

The distinctly positive results which we obtained with collections of insects consisting only of flies leaves no doubt that they are carriers of the virus. The proportion of the different varieties of flies present in the virus-positive batches was noted and representative specimens, preserved in the frozen state, were kindly identified for us by Mr. David G. Hall, of the Bureau of Entomology of the U. S. Department of Agriculture. In Atlanta the bait consisted of sliced bananas sprinkled with sugar, and more than 95 per cent. of the flies consisted of *Musca domestica;* the virus was isolated from 1 of 3 batches tested and the flies in the positive sample consisted of 203 specimens of *Musca domestica* and 5 blowflies of which 3 can be classified as *Calliphoridae: Phaenicia sericata* (Mg.). In Cleveland fresh meat was added to the bananas and sugar, and the specimens which were caught and shown to carry the virus consisted of flies, 90 to 95 per cent. of which belonged to the *Calliphoridae* (blowflies) and the remainder to the family of *Muscidae.* The virus was demonstrated in 7 of the 12 batches tested. The large majority of *Calliphoridae* were *Phaenicia sericata,* and only few or rare specimens of the following were encountered: *Phormia regina* (Mg.), *Protophormia terrae-novae* (R.–D.), *Cynomyopsis cadaverina* (R.-D.) and *Calliphora erythrocephala* (Mg.). The *Muscidae* were mostly *Musca domestica* L. with only occasional representatives of *Muscina stabulans* (Fall.) and *Ophyra leucostoma.* Virus was isolated from one collection of flies in which only *Phaenicia sericata* (green bottlefly), *Protophormia terrae-novae* (black blowfly) and *Musca domestica* were present. While it is possible that a variety of species of the *Calliphoridae* and *Muscidae* can carry the virus, future studies with more specific baits and careful selection of individual species will greatly elucidate this question. It should be noted that we were unable to obtain positive results with Rhesus monkeys, and because Cynomolgi are needed, these studies will probably have to be postponed until importation from Java is again possible.

Because we have recently been able to demonstrate the presence of poliomyelitis virus in the blood of Cynomolgus monkeys paralyzed after oral infection with a strain of recent human origin (unpublished data), we believe that blood-sucking and biting insects should not be completely left out of consideration. Perhaps the reason the experiments of Rosenau and Brues[2] and of Anderson and Frost[3] on the experimental transmission of poliomyelitis from monkey to monkey by means of the biting stable-fly (*Stomoxys calcitrans*) could not be repeated by the same workers nor by others, is that a strain of sufficiently recent human origin may not have been used in the later experiments, rather than that epizoic parasites like fleas may have escaped attention, as Professor Brues suggests.

We can not quite agree with Professor Brues when he says that it is growing "increasingly evident that the spread of poliomyelitis can not be traced to direct human contact nor to indirect contact through healthy

* Aided by a grant from the National Foundation for Infantile Paralysis, Inc.

[1] A. B. Sabin and R. Ward, SCIENCE, 94: 590, 1941.

[2] M. J. Rosenau and C. T. Brues, *Bull. State Bd. Health,* Massachusetts, 7: 314, 1912.

[3] J. F. Anderson and W. H. Frost, *U. S. Public Health Repts.,* 27: 1733, 1912; *ibid.,* 28: 833, 1913.

human carriers. . . ." Careful investigation of a small outbreak of the disease in a Chicago suburb last summer revealed a striking example of spread by carriers.[4] Furthermore, poliomyelitis has long been reported to occur in the winter, although the virus had not been isolated from winter cases. In recent weeks we have been able to convince ourselves of the existence of winter poliomyelitis by isolating the virus from the stools of one paralytic and one non-paralytic case in Cincinnati in the middle of January, as well as from an apparently healthy younger sibling of each of these patients. Professor Brues is especially inclined to throw suspicion on rats because as he says "the virus can now readily be propagated in certain rodents. . . ." While it is true that Armstrong established *a* strain of poliomyelitis virus in cotton rats and mice in 1939, it is unfortunately not true for numerous strains of virus of human or recent human origin which have been tested in rats and mice since that time. The virus of "spontaneous poliomyelitis" of mice (Theiler's virus) may be pathogenic for cotton rats but is without effect in monkeys.[5] And one of the criteria which we and others have found applicable to the large numbers of poliomyelitis strains that have been isolated from human beings and flies is that while producing paralysis in monkeys they are not pathogenic for mice, guinea pigs and rabbits.

We believe that the search for a reservoir of poliomyelitis virus among lower animals is worth while and should continue. It is also evident, however, that epidemiologically poliomyelitis seems more to resemble diseases like typhoid fever and dysentery in which the chief reservoir of infection is in human excreta and both direct and insect spread may be possible, rather than some or all of the summer encephalitides where the chief reservoir appears to be in lower animals with spread occurring by means of a specific insect (mosquito) vector. Having isolated the virus from winter cases, we are inclined to regard poliomyelitis as a disease which occurs the year round but has a greater incidence during the summer and autumn because greater dissemination of the virus may be made possible by a number of factors, including insects such as flies.

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PLAGIOTROPIC HABIT OF GROWTH IN NORWAY SPRUCE

LATERAL twigs from the lower branches of Norway spruce trees when used as cuttings yield some rooted cuttings with the new terminal shoot developing at an angle from the vertical. This plagiotropic habit of growth if persistent would be highly undesirable for forest planting stock. Observations of this feature have been made in connection with studies[1, 2] of the vegetative propagation of Norway spruce trees during the past three years.

In one collection of 650 cuttings from trees 26 years old plagiotropic growth was evident in 19.4 per cent. of the cuttings three months after planting. In another collection of 600 cuttings from trees 40 years old plagiotropic growth occurred to the extent of 14.4 per cent. Some of the rooted cuttings were planted outside in a nursery, while others were potted and grown in a greenhouse.

By the end of the first growing season the plagiotropic habit of growth was less evident than earlier. With maturation of the stem tissues a number of the terminal shoots which had been but slightly plagiotropic earlier now assumed a vertical or almost vertical position. This is similar to the growth habit of a lateral shoot of the terminal whorl of a conifer whose leading shoot has been injured or removed. The plagiotropic habit was maintained by some of the shoots throughout the first year but gave way to normal vertical orientation of the terminal shoot in the second year. The habit of growth of the terminal shoots of the trees during the third year was normal and indicates that subsequent growth will be normal. It is believed that an early expression of plagiotropic growth in some rooted cuttings of Norway spruce does not offer a serious objection to the employment of vegetative reproduction of this species.

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A SIMPLE AIR-RAID ALARM

A SIMPLE air-raid alarm system has been developed and installed by the Cranbrook Institute of Science, which would be suited to many other buildings, particularly those already equipped with public-address systems.

A switch and radio volume control unit are placed near the telephone switchboard, over which warnings would be received. The unit controls a bank of radio amplification tubes, which build up the unholy noise of a tone-oscillator tube, the wail of which is controlled by the operator in accordance with the official fluctuating two-minute warning or the steady "all clear" signal. The sound is broadcast through eight-

[4] E. A. Piszczek, H. J. Shaughnessy, J. Zichis and S. O. Levinson, *Jour. Am. Med. Asn.*, 117: 1962, 1941.
[5] M. Theiler, *Medicine*, 20: 443, 1941; P. K. Olitsky, *Proc. Soc. Exp. Biol. and Med.*, 45: 339, 1940.

[1] C. G. Deuber and J. L. Farrar, SCIENCE, 90: 109–110, 1939.
[2] C. G. Deuber, *Trans. Connecticut Acad. Arts and Sci.*, 34: 1–83, 1940.

inch permanent-magnet speakers, but two of which were required for our building of five floors. The cost of equipment was approximately $25.00.

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ENTOMOLOGY AND WARFARE

A YOUNG friend of mine, a keen student of insects, has recently been taken over by the military authorities as an entomologist. He does not know where he will be sent or did not when I talked with him, but he has a keen sense of the possibilities of such a position, and is very enthusiastic about it. Years ago, I met Sir David Bruce in Madeira, and he commented on the great opportunities for work connected with the transmission of disease in the tropics and the unwillingness or inability of most resident medical officers to take up this work, in addition to their regular duties. If our military authorities are now establishing entomological units, with trained workers, in all the places where our troops are stationed in the tropics, the results will certainly be of great importance. Sickness and death will be prevented, and information will be obtained which will be of value in times of peace.

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QUOTATIONS

IMPACTS OF THE WAR ON AGRICULTURAL SCIENCE AS INDICATED BY THE DECEMBER SOCIETY MEETINGS

So many of the scientific societies of agricultural interest hold their annual meetings in late December that this period normally assembles more research workers in agriculture than any other of the year. For this reason these gatherings furnish an unusual opportunity to obtain a cross section of current thought and trends in some of the most important fields. In this respect, the 1941 meetings were no exception. Although formulation of their programs was well advanced before Pearl Harbor, the war and its impacts inevitably permeated whatever was said and done.

Three main groups of these meetings were attended by representatives of the Office of Experiment Stations. The largest in point of numbers and constituent bodies was that at Dallas, Texas, centering around the American Association for the Advancement of Science and including among others the American Phytopathological Society, the Society for Horticultural Science, the Society of Plant Physiologists and the Mycological Society, the Genetics Society and the Potato Association of America. A second group was that of nation-wide social science societies, held in New York City and including among others the American Farm Management Association and the Rural Sociological Society of America. The third was held in San Francisco and included the American Association of Economic Entomologists and the Entomological Society of America. All these groups were largely attended, and there was the customary substantial representation from the Federal Department of Agriculture and the land-grant colleges and experiment stations.

One of the organizations giving special attention to the war situation was the American Phytopathological Society. This society scheduled a panel discussion, sponsored by its extension work and relations committee and having as its topic for discussion Plant Pathology in Relation to National Defense and Post-War Readjustments. The meeting was opened by Director C. R. Orton, of West Virginia, who took up the national emergency programs as to crop production and garden goals and set forth the plant disease program involved. Other speakers drew attention to the opportunity for increased service to Latin America, the fungicide and spray machinery situation and the need of better transmission of research findings to the farm. On this last point, it was stated that less than half the states now have extension plant pathologists. In an attempt to remedy some of the difficulties in this direction, a group of southern plant pathologists set aside their original program for a special conference to consider what they might do of a war-time value and formulated simple, specific directions for the control of tomato wilt, sweet-potato wilt and other *Fusarium* wilts of southern crops.

The society as a whole voted to affiliate with the American Society of Agricultural Sciences. Thereby it became the first society in this country to effect association with this good-neighbor group established to promote helpful relationships among the agricultural scientists of the American Republics.

Probably the most significant action of the phytopathologists was their formation of a war emergency committee, consisting of their retiring president, Dr. J. G. Leach, of West Virginia; Dr. E. C. Stakman, of Minnesota; Dr. R. P. White, formerly of the New Jersey Stations; and their newly elected president, Dr. L. M. Hutchins, of the U. S. D. A. Bureau of Plant Industry. Regional representatives for the New England, Middle Atlantic, Southern, Upper Mississippi Valley and Pacific Divisions and representatives for plant quarantine, research, extension and fungicide manufacture were also designated. A ten-

tative program of war services dealt with such matters as the codifying for immediate use of existing information on plant disease prevention, an expanded extension service, redirection of current research programs toward emergency uses and increase of special emergency experimentation, reexamination of long-time basic research projects, intensification of plant disease survey work, tightening of plant quarantines and the holding of regional conferences as a basis for developing coordinated action and research programs to meet war needs in the different areas. Reports were received from several states which indicated that already energetic work was proceeding within the experiment stations to reconstruct their departmental research programs to meet war emergency needs.

The Genetics Society of America adopted resolutions referring to the continuity of fundamental research, now destroyed by war in almost all parts of the world, as "probably the most important investment that can at present be made for the benefit of the post-war period." It urged upon Congress and the Federal Government "the importance of safeguarding the continued prosecution of fundamental research by those institutions which are now supported by Federal funds."

The sociological discussions in New York City centered very definitely around the war situation. One session dealt with rural population and national defense, and another with an agricultural program for defense and the post-war period. Rural health received emphasis in a number of programs, notably in an appeal by Dr. M. L. Wilson, of the U. S. D. A. Extension Service, for a wide use of our knowledge of nutrition in carrying out agricultural policy and by Miss Dorothy Dickens of Mississippi on the family and national defense. There was also a session on rural institutions and national defense, in which the school and the church received special attention. Still another set of papers dealt with the integration of social research in the Americas and cultural barriers to American solidarity. Much interest was shown by the rural sociologists as a group in the organization of their research for maximum effectiveness on a wartime basis and the need of making readily and widely available whatever findings could be synthesized and applied in emergency production.

The entomological meetings at San Francisco naturally drew their attendance largely from the western states, but the problems considered in the various papers and conferences represented the major phases of national entomological effort. One of the most profitable sessions of the economic entomologists developed in the extension section where the entomologists' place in national defense was discussed. It was pointed out that 32 entomologists are following their profession as commissioned officers in the armed forces, 10 of whom are in the Navy and 22 in the Army. In other instances, professional entomologists are cooperating with military authorities in sand-fly and mosquito control, location of camps, etc. The need for adjustments of long-time research projects was mentioned. It was pointed out that large-scale operations are probably essential during the present emergency. Several authorities on insecticides mentioned the shortage of various essential materials. For example, many of the oils needed in the West are now going for aviation purposes; rotenone can no longer be obtained in quantity; enough arsenic is difficult to get at the present time. The association reaffirmed its desire to be of service in any way possible during the present state of emergency and expressed its willingness to cooperate with other groups with which its service may be coordinated.

Thus regardless of the place of assembly or the field of special interest, we find agricultural science mobilizing to render a maximum of assistance. In these meetings plant pathologists in Dallas, rural sociologists in New York City and economic entomologists in San Francisco alike demonstrated the solidarity of the personnel engaged in agricultural research in the nation and by typically democratic procedures indicated distinct progress in reorganizing their work to meet the new conditions and needs.—*Experiment Station Record.*

SCIENTIFIC BOOKS

DARWIN AND OUR INTELLECTUAL HERITAGE

Darwin, Marx, Wagner. Critique of a Heritage. By JACQUES BARZUN. xii + 420 pp. Little, Brown and Company. 1941. $2.75.

A BOOK about Darwin, Marx and Wagner all at the same time will cause some lifting of eyebrows. The author explains the juxtaposition of names in the first sentence of the preface: "This book has not three subjects, but one. That one is simply the prevailing form of our thinking in an age of materialism and machinery." Darwin, Marx and Wagner were in some way responsible for, or at least have symbolized the advent of, the current ideas in their respective spheres—science, social science and art. "Through their efforts, feelings, beauty, and moral values were shown to be illusions for which the world of fact gave no warrant." And "when the layman carries his thoughts beyond what he can see and touch, mecha-

nistic materialism becomes a menace." The present world catastrophe is the upshot.

The author is neither a biologist nor an anti-evolutionist. He is an outstanding historian and philosopher interested in the development of the intellectual climate of our time. Asking Professor Barzun's forgiveness, we shall consider only the part of his book dealing with Darwin. To many a biologist his treatment of Darwin will seem irreverent to the point of blasphemy. But the author's arguments can not be shrugged off so easily. Darwin's theory of evolution has gained a general acceptance, while theories of his predecessors had failed to do so. We have been taught that the cause of Darwin's success lies in the mass of evidence carefully marshalled by Darwin in support of his views. The author does not deny this explanation. However, he points out that the intellectual tastes of Darwin's age were peculiarly favorable for adoption of just that kind of a theory. "To scientists and laymen alike, the appeal of natural selection was manifold. It had the persuasiveness of 'small doses'; it was entirely automatic, doing away with both the religious will of a creator and the Lamarckian will of his creatures; it substituted a 'true cause' for the 'metaphysical' sort of explanation; lastly, natural selection was an exact parallel in nature to the kind of individual competition familiar to every one in the social world of man." In a period of imperialistic expansion the theory of natural selection lent itself to misuse to confer a semblance of respectability on dastardly political doctrines. "Darwin did not invent the Machiavellian image that the world is the playground of the lion and the fox, but thousands discovered that he had transformed political science. Their own tendencies to act like lions and foxes thereby became irresistible 'laws of nature' and 'factors of progress,' while moral arguments against them were dubbed 'pre-scientific.'"

It is to be regretted that Professor Barzun did not confine himself solely to historical criticism and could not resist the temptation to judge biological theories on their scientific merits. The theory of natural selection has certainly been debased, but it happens to be, in its modern form, a description of a well-established agent of evolutionary change. It does not require life-and-death utility of the evolutionarily effective variants, it is perfectly compatible with the "orderliness in the facts of heredity and variation," and it is certainly much more than "the right wrong idea" to convince the uninitiated in the truthfulness of the proposition that organic evolution has taken and is taking place. No references to authorities, however well chosen, can discredit natural selection in its proper sphere. In the reviewer's opinion the author's emphasis on the fact that Darwin was by no means the first evolutionist, and that he has, probably unconsciously, used certain ideas of his predecessors without proper acknowledgment, hardly detracts much from Darwin's stature as a scientist. After all is said and done, it is Darwin who has advanced the first evolution theory which has on the whole withstood the experimental tests imposed on it and which has developed into the modern edifice. True, it has changed greatly in the process, but so has physics since the times of Galileo and Newton.

The usefulness of the book of Professor Barzun stems from the fact that, as he correctly remarks, "science is not only man-made but man-used." Neither a biologist nor a layman can be disinterested in the uses to which the product of the scientific work is put. In this realm the evaluation can best be made by a historian. The brilliantly written and thought-provoking book of Professor Barzun will certainly repay a careful reading and contemplation.

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SPECIAL ARTICLES

GROWTH STIMULATION BY SULFANILAMIDE IN LOW CONCENTRATION

THE bacteriologist is well acquainted with the growth-stimulating effect of toxic materials in low concentration. Probably the best-known substances in this respect are the toxic cations on which extensive exact quantitative studies have been made.[1] But a wide variety of dissimilar substances have been noted to show the same stimulative action. Fred[2] has recorded observations on ether and salvarsan. Rahn[3] quotes Hofmann, who studied the phenomenon for lysol, atropin, saponin, malichite green, etc. More recently Beckwith and Geary have reported on indol-3-acetic acid.[4] There are a great number of other published observations.

Inasmuch as no such work has been reported in connection with sulfanilamide or other therapeutically significant sulfa drugs a study of sulfanilamide was undertaken.[4a] A qualitative method, the agar cup plate

[1] Margaret Hotchkiss, *Jour. Bact.*, 8: 141, 1923.
[2] E. B. Fred, *Zentralbl. f. Bakt.* (abt. 2), 31: 185, 1912.
[3] O. Rahn, *Physiology of Bacteria*, 1932, Blakiston, Philadelphia.
[4] T. D. Beckwith and E. M. Geary, *Jour. Inf. Dis.*, 66: 78, 1940.
[4a] Since submitting this paper a study has appeared (SCIENCE, 95: 104, 1942) by H. A. Johnson reporting stimulative action on luminous bacteria. The present data can be interpreted to support Johnson's hypothesis that sulfa-drug action is related to general theories of

technic,[5] was employed. In addition some tests were run by placing either 5-grain or 7.5-grain sulfanilamide tablets in the center of a sterile petri plate and pouring agar inoculated with a milliliter of an 18-hour broth culture of bacteria or 48-hour broth culture of yeast. Depending on the organism, the tablet or agar cup filled with sulfanilamide was surrounded by a zone of no growth or partial growth. At the edge of the area of inhibited growth stimulation was indicated by the appearance of a zone of growth heavier than elsewhere in the plate. Control plates were poured to check the distribution of inoculum in the agar and the possible influence of technique. For the bacteria, a beef infusion to which was added 2 per cent. sodium chloride, 1 per cent. Difco-peptone and 0.05 per cent. glucose was used. This was adjusted to pH 7.6. Czepak's medium was employed for the yeasts studied.

The following bacteria from our stock culture collection showed no zone of stimulation: *Lactobacillus acidophilus, Streptococcus fecalis, S. zymogenes* (both a proteolytic and non-proteolytic strain), *S. durans, S. mastiditis, S. pyogenes group A* (strains Dochez, J 17A4), two strains of *S. lactis, Escherichia coli, Aerobacter cloacae, Salmonella schottmulleri, S. paratyphi, Shigella gallinarum, Klebsiella ozaenae, Staphylococcus citreus, S. albus, Sarcina ventriculi, Micrococcus nitrificans.* Irregular results were given by *Aerobacter aerogenes* and two strains of *Eberthella typhi.*

Stimulation was exhibited by a strain of *Pseudomonas aeruginosae* and *Alkaligenes fecalis.*

Of 29 strains of aerobic spore-forming bacteria tested, 12 which represented strains of *Bacillus vulgatus, B. mesentericus* and *B. mycoides,* showed zones of stimulation. Gram stains prepared from cells in the stimulation zone and from normal growth revealed no obvious or systematic differences. In one case cells from the stimulation zone showed a greater number of chain formations. In another case the cells were larger.

Of 12 strains of *Bacillus vulgatus* (identified according to published criteria[6]) 7 showed a zone of stimulation. Thus the effect seems to be an intra-species one rather than related to the species.

The zone of stimulation did not always appear in the early stages of growth. Often it became visible only after 72 hours of growth.

In the case of the yeasts, an unidentified strain of *Torulaspora* showed a zone of slight stimulation. The following were not stimulated: *Torula glutinis, T. cremoris, Saccharomyces cerevisiae, S. ellipsoideus, Willia anomala, Zygosaccharomyces bailii, Oidium lactis, Monilia nigra.* The yeasts were incubated at room temperature and observed at the end of 72 hours and 7 days.

Will an organism manifest stimulation by one toxic substance and not another? Apparently it will, as tests run on *Escherichia coli, Bacillus subtilis, Willia anomala* and a few others gave a stimulation zone with bichloride of mercury and not with sulfanilamide.

Of late there has been renewed interest in the therapeutic efficacy of anti-bacterial substances produced by microorganisms. It would be informative to know whether they too exhibit a stimulative action in low concentrations. Waksman[7] in a review of the subject of bacterial antagonism makes no mention that the question has been considered. Yet it is evident that for one of these substances, actinomycin, a stimulative effect is exerted on *Bacillus mycoides* and *Sarcina lutea* as photos published in a paper[8] describing *Actinomyces antibioticus* clearly show zones of stimulation.

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narcosis, and possibly bring some of the biologically produced antagonistic substances within the ken of narcotic mechanisms.

[5] U. S. Department of Agriculture Circular No. 198, 1931.

[6] C. Lamanna, *Jour. Inf. Dis.*, 67: 193, 1940.

[7] S. A. Waksman, *Bact. Rev.*, 5: 231, 1941.

[8] S. A. Waksman and H. B. Woodruff, *Jour. Bact.*, 42: 231 (fig. 1), 1941.

INCREASED LIVER ARGINASE ON ADMINISTRATION OF ADRENOCORTICAL AND CORTICOTROPIC HORMONES[1]

IT has been shown in recent years that dietary conditions may affect the arginase content of the liver of rats. Thus, as would perhaps be expected, factors leading to increased deamination and gluconeogenesis, such as high protein diets or fasting, were found to increase liver arginase.[2] An investigation of the action on liver arginase of hormones known to control the rate of gluconeogenesis appeared indicated.

Liver arginase was determined in several groups of hypophysectomized rats which had received 15 daily injections of pituitary extracts high in adrenocorticotropic activity (ACT H),[3] and in one group which had been similarly treated with cortin (Adrenal Cortical Extract, Upjohn).[4] In each case a considerable

[1] Aided by grants from the Board of Research of the University of California and the Rockefeller Foundation, New York City, and Parke Davis and Company, Detroit, Michigan. We wish to acknowledge assistance from the Work Projects Administration, Project No. OP-65-1-08, Unit A-5.

[2] D. H. Lightbody and A. Kleinman, *Jour. Biol. Chem.*, 129: 71, 1939; *Proc. Soc. Exp. Biol. and Med.*, 45: 25, 1940.

[3] Prepared according to an as yet unpublished method of C. H. Li, of this laboratory.

[4] The determination and the calculation of arginase unitage were performed according to Edlbacher (S. Edlbacher and H. Röthler, *Zeits. physiol. chem.* (Hoppe-

increase in the arginase content of the livers of the treated rats was evident (see Table I). In a few

TABLE I

EFFECT OF ADRENOCORTICOTROPIC HORMONE (ACT H) AND OF CORTIN ON LIVER ARGINASE OF HYPOPHYSECTOMIZED RATS*

Exp. No.	Treatment	Liver Arginase Content		
		per g Liver (Units)	per 100 g Rat (Units)	Increase Per cent.
1	ACT H treated	2,700	8,400	+ 75
	controls	1,675	4,800	
2	ACT H treated	2,350	8,450	+220
	controls	800	2,640	
3	ACT H treated	2,000	7,200	+ 82
	controls	1,200	3,960	
4	Cortin treated	2,550	7,900	+193
	controls	925	2,700	

* All fasted 21 to 24 hours preceding autopsy, after an injection period of 15 days. Treated rats in expts. 1 to 3 received 3.9 mg of the hormone preparation daily and three times during the 24 hour fast. Rats in expt. 4 received 0.5 cc of Upjohn's Adrenal Cortical Extract twice daily, with three injections of 1 cc during the 24 hour fast. The rats in expts. 1 to 3 were males, approximately 50 days old at operation and injected from the first day p.o. on. Those of expt. 4 were females, operated when approximately 30 days and injected after a postoperative period of 1 to 2 weeks.

The ACT H preparation used contained about 5 to 10 per cent. lactogenic hormone and less than 1 per cent. of other known hormones. The adrenal weights of the treated animals average 51 mg, those of the controls 14 mg.

groups, liver arginase was determined after treatment with the same dose of ACT H in combination with lactogenic hormone; also after the same cortin treatment, combined with growth hormone. In each case increases were found, but these were somewhat less pronounced than those brought about by ACT H or cortin alone. Studies of the effect of various other purified pituitary hormones and of thyroxin are in progress. As was noted by Lightbody,[5] we find the hyperthyroid state, produced by high doses of thyroxin in normal rats, to be associated with a tendency to increases in liver arginase; physiological doses of thyroxin in hypophysectomized rats seem to have the opposite effect.

The striking increases in liver arginase produced by pituitary adrenocorticotropic preparations, as well as by an adrenal cortical extract, are in good agreement with the theory that the adrenal cortex plays a predominant role in the hormonal control of gluconeogenesis. It has been established through the work of Long[6] and others, that certain hormones of the adrenal cortex enable fasting animals to maintain or even increase their carbohydrate stores, at the expense of body proteins; a similar action of ACT H has been demonstrated by Bennet[7] and has since been amply confirmed by us. It is obvious that the action of these hormones in increasing liver arginase would favor gluconeogenesis.[8]

Studies are under way as to the effect on liver arginase of purified pituitary hormones under varied conditions in normal and hypophysectomized rats. The liver arginase increasing activity of various pure adrenocortical steroids should also be tested.

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THE EFFECT OF A PREPARATION OF AMINE OXIDASE ON EXPERIMENTAL HYPERTENSION

THERE is evidence that deamination but not decarboxylation of certain amino acids is incomplete in kidneys deficient in their supply of oxygen.[1,2] Since decarboxylation of amino acids leads in many instances to the formation of pressor amines, it was believed that this process might be responsible for some varieties of arterial hypertension. Because the enzyme tyrosinase lowers the blood pressure of hypertensive animals and human beings,[3,4] a phenolic compound is probably concerned in the existence of this condition. It was desirable that other enzymes with known activity be employed in arterial hypertension in order that something further be learned regarding the nature of the pressor substance or substances.

A preparation of hog liver containing active amine oxidase, an enzyme specific for certain amines,[5] was, therefore, given to animals. The intravenous injection of a small amount of this material consistently lowered the blood pressure of hypertensive rats, affecting that of normal ones to a less extent. When this preparation was mixed with a solution of angiotonin or tyramine the pressor response of these substances was abolished. Rats which had been injected

Seyler), 148: 264, 1925) and Takehara (H. Takehara, *Jour. Biochem.* (Tokyo), 28: 309, 1938), using xanthydrol for urea determinations. Since no activator was added to the crude liver extracts the determinations are regarded as indicating the amount of naturally activated arginase only. All rats were fasted 21 to 24 hours preceding autopsy.

[5] D. H. Lightbody, E. Witt and A. Kleinman, *Proc. Soc. Exp. Biol. and Med.*, 46: 472, 1941.

[6] C. N. H. Long, B. Katzin and E. G. Fry, *Endocrinology*, 26: 309, 1940.

[7] L. L. Bennet, *Proc. Soc. Exp. Biol. and Med.*, 37: 50, 1937.

[8] Liver and muscle glycogen and blood sugar were determined in all rats included in the table; nitrogen excretion during the 24-hour fasting period was determined in experiment 1. While these results will be presented elsewhere, it should be stated that they indicated a definitely increased rate of gluconeogenesis in the treated animals.

[1] P. Holtz, K. Credner and H. Walter, *Zeits. physiol. Chem.*, 262: 111, 1939.

[2] R. A. Bing, *Am. Jour. Physiol.*, 132: 497, 1941.

[3] H. A. Schroeder and M. K. Adams, *Jour. Exp. Med.*, 73, 531, 1941.

[4] H. A. Schroeder, SCIENCE, 93: 116, 1941.

[5] H. Blaschko, D. Richter and H. Schlossman, *Biochem. Jour.*, 31: 2187, 1937.

with the enzyme were partially or totally refractory to the pressor action of renin.

The material (liver extract) was then injected intravenously in daily doses into five dogs made hypertensive by the Goldblatt[6] technique. The blood pressure of all fell to normal levels within three to five days. The blood pressure of five normal dogs was similarly affected, but less. Associated with the fall was a reduction in the amount of urea nitrogen in the blood. A return to previous levels occurred a few days after the injections were stopped; when it was resumed the changes were repeated. In two hypertensive dogs the blood pressure and urea nitrogen both fell, but giving, subsequently, larger doses resulted in a further fall in blood pressure, a rapid rise in urea nitrogen, and death from uremia. Subcutaneous injections of this substance were followed by similar changes, but abscesses occurred. It was for that reason impossible to estimate the nature of the effect on hypertension. Larger quantities of the material given by mouth had little or no effect in three dogs and one monkey. The changes observed did not result from the action of non-specific proteins; aliquot amounts of horse serum and ten preparations of inactivated enzyme, given daily, did not affect blood pressure.

The preparation appeared to be somewhat toxic to anesthetized rats, but did not adversely affect unanesthetized dogs. The material was insoluble and the enzyme unstable. It did not oxidize phenols. As many impurities were present it can not be concluded that the results were due to the action of amine oxidase, but this interpretation is possible. If so, amines are concerned in this type of hypertension.

Note: The author is indebted to Merck and Co., for supplying the preparation of amine oxidase.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE USE OF BROMOFORM IN THE SEPARATION OF NONCALCAREOUS MICROFOSSILS

POLLEN grains, plant spores, diatoms, sponge spicules and other microfossils are much more commonly present in unconsolidated sediments of Cenozoic age than has ordinarily been assumed. If properly identified, the microfauna and microflora of such deposits may prove to have great value in correlation and in studies dealing with the climatic and other conditions at the time and place of deposition. The separation of foraminifera and other calcareous microfossils from sediments by means of heavy liquids such as bromoform has become standard practice in many petrographical studies.[1] The value of such methods for the separation of the non-calcareous microfossils has not, however, been generally recognized.

During the last few years the writer[2] has been using a bromoform-acetone solution of a standard specific gravity to separate such fossils from various types of unconsolidated sediments ranging in age from Cretaceous to Recent. The technique that has been developed has led to the discovery of fossils in sediments that have formerly been considered to be completely barren. The method of separation and concentration is simple, rapid and complete. The microfossils of various types are concentrated together, thus making possible quantitative studies of the different elements of the fauna and flora. The method is applicable to most types of microfossils found in sediments, including foraminifera, ostracods (with the two valves in place), radiolaria, silicoflagellates, siliceous sponge spicules, diatoms, pollen and spores of plants, and the light remains of plants and animals, which are often of diagnostic value. The method is especially valuable when dealing with sediments containing relatively few individuals.

The skeletal remains of most diatoms, radiolaria and silicisponges are composed of colloidal silica in the form of opal with a specific gravity of 1.9–2.3. Since quartz and the common clay minerals of which most sediments are composed have a somewhat higher density (2.5–2.7), it is possible to separate these siliceous fossils from unconsolidated sediments by means of a heavy liquid with a specific gravity of 2.3. Although the writer has found no previous reference to the use of heavy liquids in separating sponge spicules, radiolaria and silicoflagellates from sediments, he has found that the method has been occasionally used for the concentration of diatoms. Such a method is described by F. Hustedt.[3] In this case Thoulet solution with a specific gravity of 2.3 was employed. This solution, however, is extremely poisonous and because of its corrosive properties and the difficulties involved in its use, it is not as suitable as bromoform.

Sediments also frequently contain small numbers of

[6] H. Goldblatt, Harvey Lectures, 33: 237, 1937–1938.

[1] Marcus A. Hanna, *Econ. Geol.*, 22: 1, 14–17, 1927.

[2] Acknowledgment is gratefully expressed for financial aid received from Mr. Robert W. Sayles and the associates in science of Harvard University.

[3] F. Hustedt, "Die Kieselalgen Deutschlands, Österreichs und der Schweiz" in Rabenhorst, L., *Kryptgamen-Flora von Deutschland, Österreich und der Schweiz.* Vol. vii, pp. 189–190, 1927.

pollen grains and spores. These are customarily concentrated by using hydrofluoric acid, which dissolves out the silica and leaves the plant residue in a great enough concentration to facilitate pollen counts.[4] This concentration can be accomplished more efficiently and with less danger by using bromoform and acetone with a gravity of 2.3. Although pollen grains may be separated by means of a liquid of a lower density, experience has shown that with a high gravity solution there is less chance of loss, because there is less rapid settling of the sediment. Recently V. P. Grichuk[5] described a similar method for recovering pollen from loess deposits. The liquid used was "Toulé" (Thoulet?) solution with a specific gravity of 2.2.

The following is a description of the method that has been employed by the writer in examining various types of sand, silt, clay and till for microfossils. The method can be easily modified and can be used in conjunction with other methods commonly employed, when a greater concentration or a thorough cleaning of the microfossils to be studied is desired.

The unconsolidated sediment must first be completely broken up into its constituent parts and thoroughly deflocculated so that the fossils may be as free as possible from adhering material. With the coarser sediments this can usually be done by shaking the dried sediments in the bromoform to be used for the final separation of the microfossils, until the particles are entirely separated. With finer sediments, such as silt and clay, other methods are usually necessary. Ordinarily these sediments can be easily broken up by soaking small pieces of the material in water or in acetone followed by repeated agitation. If the sediments can not be broken up in this way, it becomes necessary to use alkalies or acids, although such means should not be used unless absolutely necessary because of the danger of destruction of some of the microfossils.

After the material is broken up and washed in acetone, it is thoroughly dried and then placed in a mixture of bromoform and acetone with a specific gravity of 2.3. After thorough mixing with the heavy liquid it is centrifuged. The light portion containing the fossils, which is found floating on the surface of the liquid, is poured off, filtered, washed thoroughly in acetone and dried over a hot plate. In most cases it is desirable to centrifuge the sediments several times in order to get a complete separation, especially when quantitative studies are being made. For preliminary work, however, it is generally necessary to centrifuge them only once. The dried material is then examined for fossils, and if present they are mounted directly or further concentrated and cleaned by methods commonly employed in the study of the different types of microfossils.

The bromoform may be recovered from the acetone washings and used again. This is done by mixing the washings in water and separating the bromoform from the water and acetone by means of a separatory funnel. It should be pointed out that bromoform is somewhat poisonous, but if it is used in a well-ventilated room or under a ventilating hood, there is no danger of unfortunate effects.

The method described above should be of considerable value to those engaged in ecological studies of modern lake sediments and deep-sea deposits as well as in many geological investigations involving the use of microfossils.

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[4] G. Assarsson and E. Granlund, *Geol. Fören. in Stockholm Förhandl.* Bd. 46 H 1–2, pp. 76–82, 1924.

[5] V. P. Grichuk (Gritchouk), *Problems Phys. Geog. Acad. Sci.*, U.S.S.R., Vol. viii, pp. 53–58 (Russian; French summary), 1940.

A NEW MEDIUM FOR MELTING-POINT BATHS

WE have found that Dowtherm A is an excellent medium for melting-point baths. This product is a eutectic mixture of 73.5 per cent. diphenyl oxide and 26.5 per cent. of diphenyl, manufactured by the Dow Chemical Company, of Midland, Michigan, for use in high temperature heat transfer systems.

Dowtherm A has an advantage over concentrated sulfuric acid in that neither the liquid nor the vapor is toxic or corrosive. It will support combustion, but will not ignite spontaneously, thus involving no fire hazard. Unlike the hydrogenated cottonseed oils often used for this purpose, Dowtherm A is liquid between 12° C. and 258° C. (at atmospheric pressures) and can thus be used for the greatest majority of melting-point determinations. It has a specific gravity of 0.995 and a specific heat of 0.63, at 100° C., and a refractive index of 1.5884, at 20° C.

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BOOKS RECEIVED

American Diabetes Association. Proceedings of the First Annual Meeting, Volume 1. Pp. 148. American Diabetes Association.

BANKS, CHARLES W. *Applied Science.* Pp. viii + 212. Wiley. $1.75.

HOWE, HOWARD A. and DAVID BODIAN. *Neural Mechanisms in Poliomyelitis.* 39 plates. Pp. vi + 234. The Commonwealth Fund. $3.50.

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The Structure of Protoplasm. Monograph of the American Society of Plant Physiologists. Edited by WILLIAM SEIFRIZ. Pp. vi + 683. Iowa State College Press. $3.00.

SCIENCE NEWS

Science Service, Washington, D. C.

THE MECHANISM OF THE SUN'S HEAT

THE sun is a giant atom-smasher, feeding on atomic energy by transmuting hydrogen into helium, with carbon playing the part of go-between and not consumed. This is the picture that was painted at Washington and Jefferson College by Dr. H. A. Bethe, professor of physics at Cornell University. Dr. Bethe spoke under the auspices of the Society of the Sigma Xi, national fraternity for the promotion of scientific research. He will lecture again at several universities and colleges during the next few days.

The precise mechanism by which the sun maintains its tremendous output of energy, by which we all live, has now been definitely worked out. It is a six-step reaction, Dr. Bethe explained, between the nuclei or central cores of elementary atoms.

In the tremendous heat that prevails inside the sun, 36 million degrees Fahrenheit at the center, chemical reactions do not occur. But when nucleus meets nucleus, something similar takes place. They may knock each other to pieces and the fragments recombine to form new elements. Or a nucleus may swallow another whole, again producing a new element. At each such transmutation, a burst of energy contributes to the sun's radiation.

Already, it is estimated, the sun has existed in this way a billion and a half years. And it would continue to exist another 30 billion years, Dr. Bethe stated, if it kept on at its present rate. But the sun gets hotter as it grows older, eats up its hydrogen faster, and will probably have consumed the last morsels before ten billion years.

Five million years are required to run through the six-step reaction that maintains the sun's heat. To begin with, a carbon nucleus picks up a hydrogen nucleus and is transformed into nitrogen. The latter disintegrates to another form of carbon. This picks up an additional hydrogen nucleus, becoming a different form of nitrogen. The latter picks up a hydrogen nucleus, becoming oxygen. This oxygen disintegrates to still another form of nitrogen, which is finally struck by a hard-hitting hydrogen nucleus and completely smashed. From the fragments, two new elements are formed, helium and the original carbon with which the series started.

Thus, after some five million years, we are back where we started. Carbon has not been consumed, but has merely acted as a go-between or catalyst to keep things going. All the intermediate products have disappeared. During the process four hydrogen nuclei have been consumed, and only helium remains. Thus, hydrogen is the fuel of the solar fires, and helium is the ash.

COLLISION WITH BIRDS A HAZARD IN AIR TRANSPORTATION

COLLISION with birds, particularly large specimens, is one of the most serious hazards to transport planes, sometimes causing destruction of the plane and threatening the life of pilot or passengers, according to the report of Allen L. Morse, chief of the aircraft development section of the Civil Aeronautics Administration, read at the national aeronautic meeting of the Society of Automotive Engineers. Airplane accidents involving bird collision, Mr. Morse said, have amounted to 61 since 1939, two thirds of which occurred at night, more than a third shattering or penetrating the windshield.

Mr. Morse told of one pilot whose plane collided with a flock of five swans at night. One swan penetrated the leading edge of the left wing; the second almost tore off the left vertical stabilizer, jamming the rudders, the third swan struck and dented the engine cowl, and later two swans went through the propeller. A portion of a swan, taken from the wing after landing, weighed 11½ pounds. Wild swans weigh as much as 20 pounds.

Such reports show that impact forces in collisions with birds are enormous. Even small birds, Mr. Morse went on, not only have penetrated the windshield, but in one instance continued through the bulkhead, traveled the length of the cabin, penetrated the rear cabin wall, and lodged finally in the baggage compartment. Fortunately in this case neither passengers nor crew were struck.

For use in tests to devise adequate protection against birds, Mr. Morse called for development of a high-pressure air catapult which could shoot freshly-killed carcasses against a plane windshield, thus simulating actual flight-collision. Freshly-killed birds are necessary, since their bodies offer the same resistance as live birds. Meanwhile windshield combinations of glass and plastics offer some protection. It is to further test these combinations that the high-pressure catapult is needed.

A POWERFUL MAGNETIC FIELD DISCOVERED IN SUNSPOTS THAT BLACKED-OUT RADIO COMMUNICATIONS

THE giant group of sunspots that was visible to the naked eye from February 25 to March 1 had the most powerful magnetic field ever measured at the Mount Wilson Observatory, an investigation at Pasadena has revealed.

On two days the magnetic field attained the value of 5,100 gauss. A strength of 3,000 gauss is about average for most large spots. Although spots have been photographed and studied at Mt. Wilson on every clear day for over a quarter of a century, not one has ever exceeded this value. The spot-group was also remarkable in that it contained magnetic fields of opposite polarity almost in contact, like the north and south poles of a horseshoe magnet, instead of being widely separated as is usually the case.

The spot-group was held responsible for the violent magnetic storm which began about midnight on March 1 and lasted for 24 hours. The magnetic field of the spot itself is not believed to have caused the storm, but rather charged particles projected from the spot at a high velocity toward the earth. Frequently during magnetic storms telegraph and teletype service is disrupted and radio transmission seriously affected.

The spot-group is now out of sight on the side of the sun turned from the earth but should be brought into view again by the solar rotation about March 22.

Such a large outburst of solar activity is of exceptional interest in that it occurred only two years from the next predicted minimum in sunspot frequency. The last minimum of the 11-year cycle was in 1933 and maximum about 1937.

DISEASE-FIGHTING BLOOD SUBSTANCES

FOR the first time in medical history, disease-fighting blood substances known as antibodies have been formed artificially in laboratory flasks. Hitherto these protectors against germs and viruses have been formed only within the bodies of living persons and animals. The new feat of inducing their production in glass vessels was performed in the laboratories of the California Institute of Technology by Professor Linus Pauling, Professor Dan Campbell and Dr. David Pressman.

Up to the present time, the experiments have not been carried far enough to discover whether or not it will be possible to prepare these protective solutions in the laboratory for general clinical use, although exploratory work along these lines is already under way. The immediate value of the research lies in its contribution to a better understanding of the biochemistry of the reactions of blood proteins to the presence of disease-causers that result in the formation of protective antibodies.

According to the theoretical picture conceived by Professors Pauling and Campbell and Dr. Pressman, antibodies are formed by the modification in shape and structure of the large molecules of certain blood proteins, known as serum globulins, which takes place in the presence of disease germs or virus particles. They envision the complex structure of the molecules forming in the presence of the disturbers with certain changes that enable them to seize hold of the offenders and render them harmless. The modifications in molecular form of the globulins enable them to perform such arrests whenever the blood is invaded by germs or virus particles like those that modified their original formation.

In these experiments serum globulins were induced to "unfold" their molecules by heating or treatment with alkali, in the presence of an antigen, or disease-provoking agent. Then the unfolding force was slowly withdrawn, permitting the molecules to re-fold themselves, but with modifications due to the provocative presence of the antigen. It was found that a protein solution subjected to this treatment acquired the various characteristics of a natural blood serum which would be obtained from an animal which had been immunized with the same antigen. The investigators have prepared in this way antibodies against various simple chemical antigens, and also against a complex sugar-like compound from cultures of pneumonia germs.

STATISTICAL METHODS AND HUMAN HEREDITY

STATISTICAL statements of the probability of inheritance of a given trait in human heredity can not predict how a particular individual will turn out, but do have potential value when large numbers are taken into account, is stated by Professor J. B. S. Haldane, of the University of London, in the concluding chapter of a book entitled "New Paths in Genetics" published by Harper.

"It is true," he conceded, "that there is almost always an element of uncertainty in predictions concerning individuals. But when we deal with millions, probability becomes certainty, and conjecture accurate prediction. And when Herr Hitler writes of the evil effects of race crossing it seems worth while to point out that a race is nothing homogeneous, but a collection of very various individuals who have something in common which can only be accurately described in terms of the statistical methods which we are working out. Before we can speak accurately of the evil effects of so complicated a process as a racial cross it would be well to investigate the evil effects of a single gene substitution.

"We geneticists who are working on the accurate description and analysis of human genetics stand between two extremes, the conservatives who do not wish to see scientific method applied to human affairs, and the reactionaries who would apply half-baked science to them in the interests of a particular class or nation. Unlike conservatism and reaction, progress demands clear thinking. If this book can help towards clear thinking on human genetics it will not have failed."

Growth of cities in Europe is credited, in another chapter, with the improvement of human heredity through the wiping out of hereditary defects. When people lived and died in the same small village circle, cousins marrying cousins for generation after generation, defects resulting from recessive genes kept cropping up as a result of this inbreeding. But when people began to migrate and to mix the population, human outbreeding became the rule and many of these once common defective genes eventually became lost.

THE HIGHWAY FROM ALASKA TO THE UNITED STATES

OBJECTION to the Alaska highway route announced by Prime Minister Mackenzie King of Canada has been made by members of both American and Canadian Alaska highway commissions and the Alaskan delegate to Congress, Anthony J. Dimond.

The route they favor is closer to the Pacific coast and is known as "A" route. It is held to be "shorter, easier to build, and of greater strategic value." The selected route announced by Prime Minister King is known as the "C" route and lies some 500 miles east of the Canadian Rockies. It was recommended by the Permanent Joint Board of Defense.

According to Mr. Dimond, the selection of the farther inland route was "a grievous mistake," an opinion concurred in by Donald MacDonald, a member of the Alaska International Highway Commission of the American Government and its acting chairman, Thomas Riggs. Both of these members pointed out that the "A" route has been the choice of this commission and the British Columbia-Yukon-Alaska Commission since 1938 when the two commissions were appointed by President Roosevelt and the Canadian Government, respectively.

Mr. MacDonald, engineer member of the American Commission and a student of the Alaska highway prob-

lem since 1928, told Science Service that the section of the route announced by the Prime Minister between Watson Lake and White Horse, Alaska, creates "extremely difficult" engineering problems. This section is a strip of about 240 miles of frozen tundra. Beneath this is a layer of mush or water which has seeped down through the tundra. To construct a road over this will be virtually impossible.

Mr. MacDonald and Mr. Dimond both stressed that the "A" route, which would connect Prince George, British Columbia, and Fairbanks, Alaska, could connect airfields near the Canadian Pacific coast, thus aiding air reconnaissance as well as possible attack on invading air forces. Pan American Airways Alaska service now flies over this route.

The selected inland route was defended, however, by an Army engineer member of the Permanent Joint Defense Board, who asked that his name be withheld. This spokesman said the inland route was chosen "purely for military reasons, and not for economic or commercial reasons." He pointed out that the inland route connects Canadian airports through Fort Nelson, Watson Lake, White Horse, Boundary and Big Delta to Fairbanks and that military authorities of both United States and Canada are agreed unanimously that the selected route is the proper one under present circumstances.

RESPIRATORY DISEASES

THE current and revolutionary theory that colds, influenza and other respiratory diseases, which cause the most illness in any age group, may be spread through the air, rather than by direct contact with the infected person, is supported by detailed evidence in the *Journal* of the American Medical Association.

Three distinct lines of investigation are reported by Dr. Leon Buchbinder, of the DeLamar Institute of Public Health of the Columbia University College of Physicians and Surgeons. These are the discovery of germs from the throat and mouth, means of identifying individual strains of streptococci bacilli, and development of several effective means to control respiratory infections on the theory that they are air-borne rather than spread by direct contact.

Most interesting perhaps are the means of control. There is suggestive evidence, Dr. Buchbinder reports, that the spread of contagious infections in children's hospitals and in operating rooms can be reduced by ultraviolet light. Somewhat the same results, though less supported by evidence, are obtained with chemical sprays.

Some time ago the contact theory seemed verified by the success of the so-called barrier method of nursing in contagious disease hospitals. However, it did not entirely prevent spread of disease from bed to bed or ward to ward. Current success with ultraviolet light and spraying the air with chemicals seems now to indicate that disease organisms may be carried for some distance through the air without losing their vigor, and may perhaps be halted by the light or spray. There have been several reports that the spread of chickenpox in institutions is slowed by ultraviolet light. The air-borne theory of contagious disease is particularly interesting at present, because of the congregation of soldiers in Army camps. One of the chemical "mists" used to halt air-borne infections is propylene glycol. It has been found that a one part to two million dilution of propylene glycol vapor will completely protect mice against dilutions of influenza virus usually fatal.

ITEMS

A RISE in tuberculosis in countries where war has caused a food shortage was predicted by Dr. Esmond R. Long, director of the Henry Phipps Institute, Philadelphia, in an address to the fortieth annual meeting of the New York Tuberculosis and Health Association. Dr. Long pointed out that already a rise in tuberculosis death rates has been recorded in the British Isles, attributed by public health authorities to poorer nutrition. He said proper nutrition is an important constitutional factor in resistance to this disease. During the first world war there was a serious rise in tuberculosis in the warring countries. Careful analyses in later years credited a major share of this to malnutrition, particularly to deficiency in protein consumption. Later studies have indicated the importance of vitamin A and vitamin C. These food substances are looked upon as protective. They may spell the difference between ability and inability to resist minor tuberculosis infections.

RESISTANCE to infantile paralysis and other diseases caused by viruses may depend on whether or not the cells of the body are thirsty for water and are well-fed or undernourished, it appears from experiments reported in the *Journal of Experimental Medicine* here by Dr. Douglas H. Sprunt of Duke University School of Medicine. Dr. Sprunt discovered in experiments on rabbits that thirstiness, not just in a dry mouth but in every cell of the body, lessens resistance to vaccinia, the virus used in vaccinating against smallpox. Infantile paralysis often strikes children and young people after athletic contests or similar physical exertion in the summer. Water sweated from the body at such times may have created such a dry, thirsty state throughout the body that the nerve cells which the infantile paralysis virus strikes were unable to resist the virus attack. When there is plenty of water in the tissues of the body, however, the virus tends to be localized at the invasion point and can not grow and spread enough to cause disease. This, at least, appears to be the mechanism in the case of the vaccinia virus and the rabbits. Food also plays a part in resistance to virus infection. Contrary to what might be expected, resistance to the virus is greater when the body is undernourished than when it is well-fed.

THAT pork can be made safe for human consumption, so far as any lurking trichinae are concerned, by proper freezing, has been determined by the U. S. Department of Agriculture. Sections of pork or pork products not more than six inches thick are freed from parasites by exposure to a temperature of five degrees Fahrenheit for twenty days, or ten degrees below zero for ten days, or twenty degrees below zero for six days. Thicker pieces may be made safe by longer freezing. The department warns that in many food locker plants temperatures are not kept low enough to insure a complete kill in stored pork.